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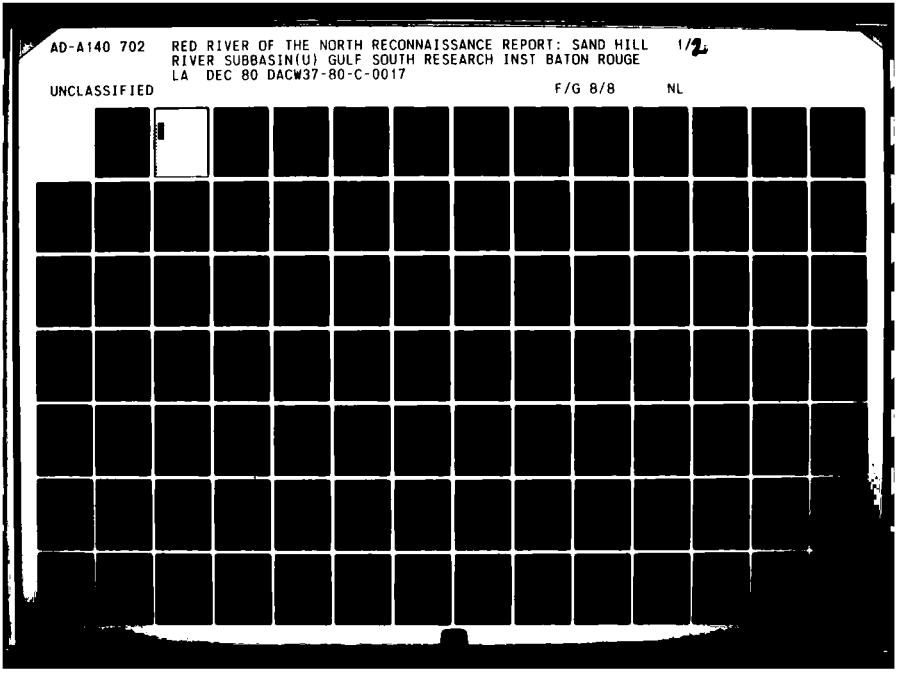

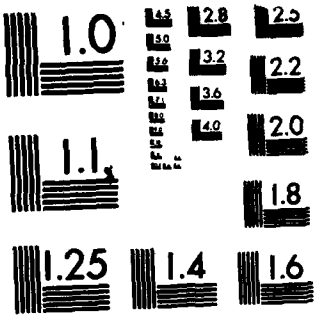

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This report is one of 23 subbasin reports produced by the St. Paul District Corps of Engineers in connection with a reconnaissance report for the whole of the Red River Basin. The reconnaissance report is itself part of the overall Red River of the North study, which was initiated by Congress in 1957 in order to develop solutions for flooding problems within the basin. The purpose of a reconnaissance study is to provide an overview of the water and related land resource problems and needs within a particular geographic area, to identify planning objectives, to assess potential solutions and

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The purpose of a reconnaissance study is to provide an overview of the water and related land resource problems and needs within a particular geographic area, to identify planning objectives, to assess potential solutions and problems, to determine priorities for immediate and long-range action, and to identify the capabilities of various governmental units for implementing the actions.

The Sand Hill River Subbasin is a water resource planning unit located in the central Minnesota portion of the Red River Basin. This report describes the social, economic, and environmental resources of the subbasin, identifies the water-related problems, needs, and desires, and suggests measures for meeting the needs, particularly in the area of flood control.

The report was prepared almost entirely on the basis of secondary information. However, some telephone contacts were made to verify information and to acquire a more complete picture of local conditions. The two comprehensive reports available on the subbasin include the Flood Control Definite Project Report on Sand Hill River, Minnesota, which was published by the St. Paul District Corps of Engineers in 1950, and the overall Plan-Sand Hill River Watershed District, which was published by the Minnesota Water Resources Board in 1977. Other published sources on the subbasin include:

1. Request to initiate Section 216 Flood Control Study for Sand Hill River, Minnesota, which was a letter submitted in 1978 by the St. Paul District Corps of Engineers and recommends that a study be done to review the existing channel improvement project.

2. Water Resources Planning and Development in Minnesota, a status of Corps of Engineers Studies, which was published in 1979 by the St. Paul District Corps of Engineers and is a brief description of proposed work on the Sand Hill River near the town of Beltrami and which estimates the initiation and completion of a reconnaissance study.

In addition, the subbasin received partial coverage in the Souris-Red-Rainy River Basins Comprehensive Study, which was published by the Souris-Red-Rainy River Basins Commission in 1972, and in the Red River of the North Basin Plan of Study, which was published by the St. Paul District Corps of Engineers in 1977.

The information developed in this report has been combined with information developed in the other subbasin reports to produce a main report covering the basin as a whole. The various flood control measures discussed in this and in other subbasin reports are combined in the main report to develop the outline of an integrated flood control plan for the basin within the context of a comprehensive plan.

II. DESCRIPTION OF STUDY AREA

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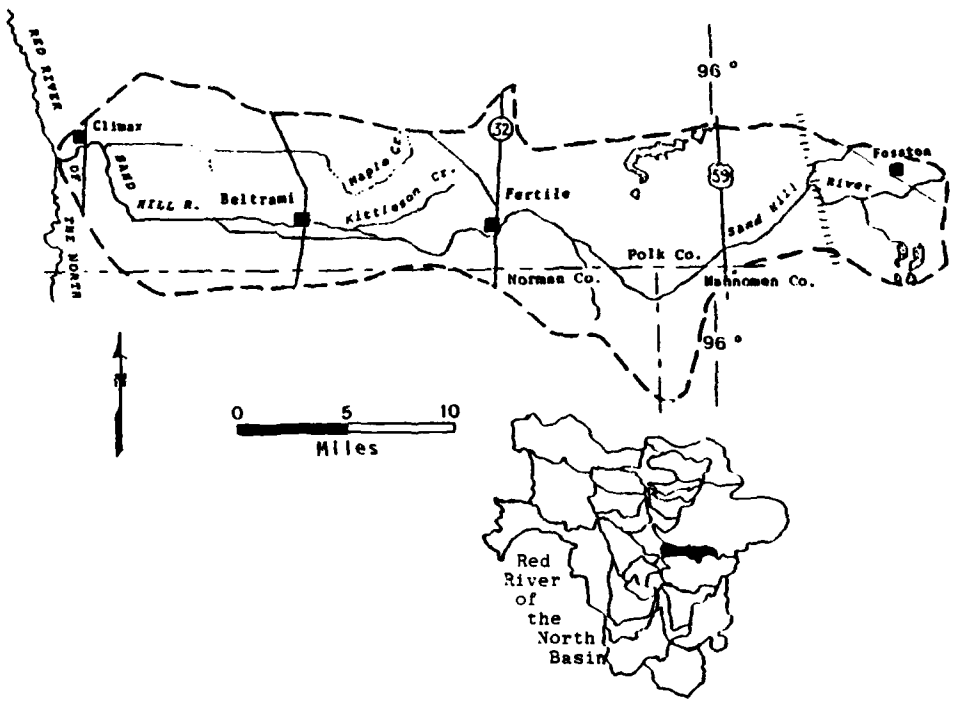
The Sand Hill River Subbasin (Figure I) is a thin rectangle about eight miles wide and 55 miles long that encompasses 484 square miles of the central Minnesota portion of the Red River Basin, including parts of Polk, Norman, and Mahnomen counties. It is one of the smallest subbasins and is sandwiched between the Red Lake River Subbasin on the north and east, the Wild Rice-Marsh River Subbasin on the south, and the Main Stem Subbasin on the west. The subbasin has attained a legal status through the formation of the Sand Hill River Watershed District in 1975.

The eastern part of the subbasin is an upland area with gently rolling terrain and numerous potholes, most of which have been drained. Originally forests were here, but almost all have been cleared to allow for farming. The western portion is the Red River Valley area, almost all of which is under cultivation. Between these two is a central region of beach, outwash, marshes, moraines, and sand dunes associated with glacial Lake Agassiz. The highest point in the subbasin is in the eastern portion, about 1,350 feet above sea level.

The Sand Hill River is the dominant water feature in the subbasin. Other major streams include Kittleson Creek and Maple Creek, both of which are located north of the river. The Sand Hill River rises in a group of lakes in the drift prairie region south of Fosston along the north-central border of Mahnomen County. Originally, the stream flowed in a defined channel to a point three miles west of Beltrami. Westerly from this point, in a reach of several miles, the channel was completely lost in a large marsh. In the early 1900's a ditch was constructed through the marshy area. After passing through the ditch, the river reenters a natural channel before joining with the Red River.



Source: Gulf South Research Institute.

Figure I. SAND HILL RIVER SUBBASIN

III. PROBLEMS, NEEDS, AND DESIRES

III. PROBLEMS, NEEDS, AND DESIRES

The primary water-related problems, needs, and desires in the Red River Basin are flood control, fish and wildlife conservation and enhancement, recreation, water supply, water quality, erosion control, irrigation, wastewater management, and hydropower. Various water-related problems, needs, and desires have been identified for the Sand Hill River Subbasin in previous planning reports on the basis of analysis of conditions and public and agency comments. The list of problems, needs, and desires for the subbasin is the same as the list for the Red River Basin as a whole, except for hydropower. Each problem is discussed separately below, with an emphasis on flooding problems.

Flooding Problems

Nature of The Problems

Floods in the subbasin usually occur in the months of March through July. This period usually produces major flooding problems, which result from spring snowmelt often made worse by rains. During some years, ice jams are known to have increased river stages by several feet. These floods may force delays in planting operations up to three weeks, resulting in depressed yields through the effect of hot weather on immature crops. In view of the limited growing season, water staying on the land too long may preclude planting entirely.

Flood damage also occurs following high-intensity summer rains. Although they occur less frequently than spring snowmelt floods, these summer floods are characterized by high peak flows that cause damage to maturing crops or make crop harvest difficult or impossible.

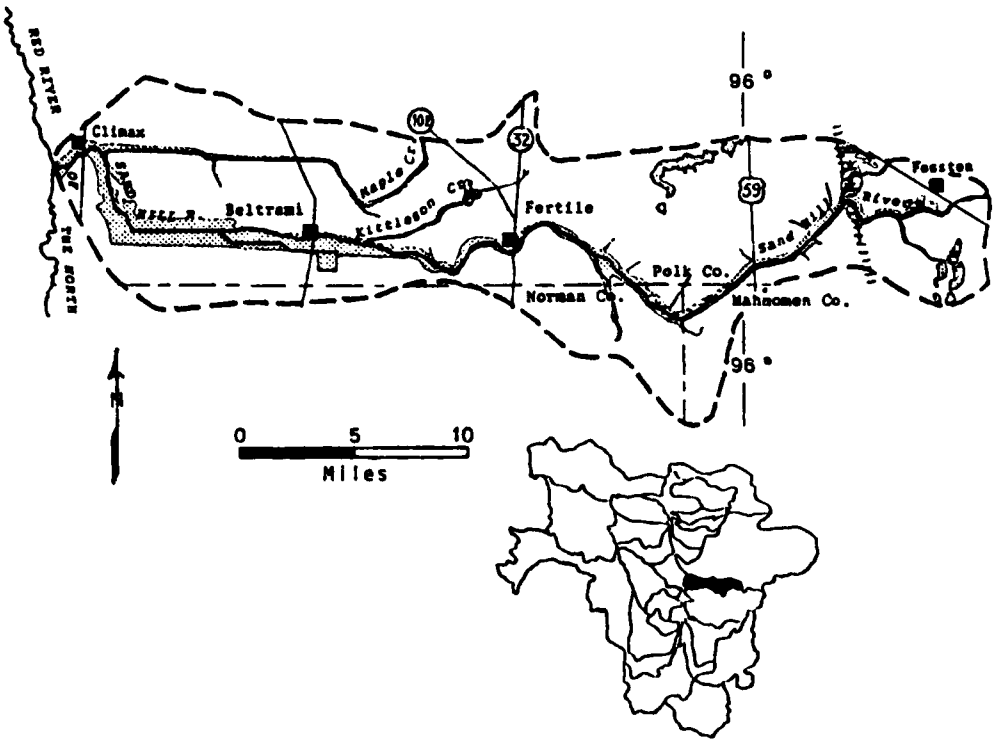
Two separate types of flooding occur: the most damaging type associated with river bank overflow (overbank flooding) and another type caused by runoff from snowmelt or heavy rainfall impounded by plugged culverts and ditches within sections of land bounded by roadways on earthern fill (overland flooding). In overland flooding, the trapped water slowly accumulates until it overflows the roadways and inundates section after section of land as it moves overland in the direction of the regional slope until reaching river or stream channels.

The topography of the subbasin also has a bearing on flooding problems. In the nearly flat terrain of the lower part of the subbasin, flood flows in excess of channel capacities move overland and inundate thousands of acres in the western third of the subbasin, disrupting transportation facilities and damaging cropland, roads, bridges, and farmsteads. The central part of the subbasin, from approximately six miles west and three miles east of the city of Fertile, consists of beach ridges, moraines and sand dunes associated with glacial Lake Agassiz. A major drop in elevation of nearly 300 feet results in a well-entrenched floodplain through this area. The upper reaches flow through an area of gently rolling terrain with numerous potholes, many of which have been drained for agriculture. Except for the area downstream from the White Earth Indian Reservation, flows in this area are generally contained in definable floodplains.

Under certain conditions, flooding within the subbasin is complicated by the fact that peak flows on the Sand Hill River often coincide with peak flows on the Red River. This causes the subbasin flow to back up and inundate large areas in the flat valley plain. Since the subbasin contains about 1.2 percent of the total drainage area of the Red River Basin, runoff from the subbasin does not contribute significantly to flooding on the Red River Main Stem.

Location and Extent

Figure II depicts the 100-year floodplain for the subbasin. A number of sources were investigated in order to produce the present delineation. Among these were: (1) U.S. Geological Survey (USGS) Flood Prone Area Maps at 1:24,000 scale; (2) Federal Insurance Administration flood maps (various scales); (3) published secondary sources describing flooded areas; and (4) USGS 7 1/2 minute topographic maps. Because the sources were sometimes incomplete and based on surveys differing in purpose and accuracy, it should be understood that Figure II is intended only for general planning purposes. A more complete description of sources and limitations is given in Appendix A.



Source: Gulf South Research Institute.

Figure II. 100-YEAR FLOODPLAIN

The Sand Hill River 100-year floodplain as delineated in Figure II is approximately 30,000 acres in size. Major components include: an upper segment of 10,000 acres in the gently rolling headwaters area; a middle segment of 4,000 acres centered east of Fertile in the beach ridge area; and 16,000 acres comprising the lower one-third of the subbasin adjoining the Red River.

The upper segment extends from Fosston to a point approximately three miles east of the city of Fertile. The configuration is largely that of Federal Insurance Administration Flood Hazard Boundary Maps supplemented by marsh patterns on USGS maps. Marsh areas in proximity to the river floodplain account for approximately 4,000 of the 10,000 acres in this segment. Extensive overland flooding occurs at the point that the Sand Hill River flows out of the White Earth Indian Reservation.

As the river traverses the beach ridge area, the width of the floodplain narrows markedly to a distance of no more than a quarter mile. This confined floodplain is characteristic of the area around Fertile and continues to a point about six miles further downstream.

At this point, the river enters the flat valley plain of the Red River in the lower segment and once again widens considerably. At the juncture with Kittleson Creek, the floodplain becomes over a mile wide. As shown in Figure II, the width increases temporarily to two miles just east of Beltrami. At a point about four miles west of that town, the floodplain broadens again to two miles before becoming much more confined some four miles south of Climax. Unlike most other Red River subbasins, the Sand Hill contains only a small area of several hundred acres that is directly associated with Main Stem flooding.

Flood Damages

The primary areas affected by flooding throughout the subbasin's floodplain are urban, agricultural, and environmental in nature. Beltrami is the only urban area located within the floodplain. The only damage categories taken into consideration in the computation of average annual damages are urban and rural.

Present average annual damages in the subbasin are estimated at $299,400, which accounts for less than one percent of the Red River Basin's average annual flood damage total. Urban and rural are the two basic classifications into which average annual damages are separated. Damages to residences, businesses (commercial and industrial) and public facilities (streets, utilities, sewers, etc.) are reported as urban damages. Damages to crops, other agricultural assets (fences, machinery, farm buildings, etc.) and transportation facilities are reported as rural damages. Rural damages account for 96 percent of the total average annual damages in the subbasin, and urban damages account for the remaining four percent.

Urban damages sustained during the 1975 flood event amounted to $40,400. The 1979 flood event resulted in $60,000 in urban damages, and average annual urban flood damages are estimated at $13,000. A more detailed breakdown of these urban flood damages is presented in Table 1.

Urban damages resulting from the 1975 flood event included $20,200 in residential damages, $16,200 in business related damages, and $4,000 in public damages. The 1979 flood event resulted in residential damages of $30,000, business damages of $24,000, and public damages amounting to $6,000. Average annual urban flood damages are estimated at $6,500 in residential damages, $5,200 in business damages, and $1,300 in public damages.

Average annual rural flood damages and the rural flood damages incurred in the 1975 and 1979 flood events are shown in Table 2. Rural flood damages sustained in both the 1975 and 1979 flood events far exceeded the average annual damages in the subbasin. Rural flood damages sustained in the 1975 flood event included $2.9 million in crop damages, followed by $781,100 in other agricultural damages and $58,600 in transportation damages. The 1979 flood event resulted in rural flood damages that included $1.4 million in crop damages, $570,000 in other agricultural damages, and $143,000 in transportation damages. In comparison, average annual rural flood damages are estimated at $206,000 in crop damages, $68,700 in other agricultural damages, and $11,700 in transportation damages. Total rural flood damages were $3.8 million in the 1975 flood event, $2.1 million in the 1979 flood event, and $286,400 on an average annual basis.

Table 1

SAND HILL RIVER SUBBASIN, ESTIMATED 1975, 1979,
AND AVERAGE ANNUAL URBAN FLOOD DAMAGES
(Thousands of 1979 Dollars)

Category	Year		Average Annual
	1975	1979	
Residential	$20.2	$30.0	$ 6.5
Business	16.2	24.0	5.2
Public	4.0	6.0	1.3
Total	$40.4	$60.0	$13.0

Sources: Red River of the North Basin Plan of Study, April, 1977; Post Flood Reports, 1975, 1979; and Gulf South Research Institute.

Table 2

SAND HILL RIVER SUBBASIN, ESTIMATED 1975, 1979,
AND AVERAGE ANNUAL RURAL FLOOD DAMAGES
(Thousands of 1979 Dollars)

Category	Year		Average Annual
	1975	1979	
Crop	$2,929.1	$1,425.0	$206.0
Other Agricultural	781.1	570.0	68.7
Transportation	58.6	143.0	11.7
Total	$3,768.8	$2,138.0	$286.4

Sources: Red River of the North Basin Plan of Study, April, 1977; Post Flood Reports, 1975, 1979; and Gulf South Research Institute.

Environmental Concerns

Much of the native prairie, wetlands, and woodlands of the subbasin have been cleared and converted to cropland or pastureland. This action has taken place since the late 1800's and still occurs to some degree, particularly with regard to wetlands. Data from the Minnesota Land Management Information Service indicate that about 92.8 percent of the total area of the subbasin is now in cultivated, urban residential, pasture and open, urban non-residential, and transportation land uses. Conversion of the original communities to these uses has eliminated or reduced the value of these habitats for plants and animals and has altered the species composition. Prevention of fires has also altered vegetation, and some areas that once supported prairie have now become established with aspen, oak, and various brush species (Upper Mississippi River Basin Commission, 1977; Minnesota Water Resources Board, 1977). Thus, there is a need to protect, conserve, and if possible enhance the remaining wildlife habitat in the subbasin.

Problems related to aquatic biota are also related to development through drainage of wetlands, small lakes, and ponds for agricultural usage. Municipal and agricultural pollution, through their influence on water quality, are probably affecting aquatic organism populations. Pollution types include untreated sewage effluents discharged into streams, septic tank discharges into lakes and streams, stormwater from cities, and runoff and effluent from livestock operations. Turbidities are excessive at times, which probably affects aquatic biota. This occurs through the introduction of soils into waterbodies from both wind and water erosion (Upper Mississippi River Basin Commission, 1977; Minnesota Water Resources Board, 1977).

Recreation Problems

Recreational opportunities in the subbasin are limited to hunting in the wildlife management areas and a few parks and campgrounds near Fertile and Fosston. The western section of the subbasin contains only a few water-based or water-related recreational resources because of the lack of lakes and topographic features. The Watershed District's Overall Plan reports pollution problems in the Sand Hill River because

of municipal and industrial effluents discharged into the river and some of the lakes. This results in diminished water quality as well as decreased recreational and aesthetic potentials. In addition, drainage of wetlands for agricultural use has reduced the quantity and diversity of wildlife in the subbasin by depriving various species of valuable habitats.

Water Quality Problems

Surface water quality data for the Sand Hill River is generally lacking. No data have been made available by the Minnesota Pollution Control Agency (1975) and the U.S. Geological Survey (1979), and no monitoring stations have been established on the stream by the Minnesota Pollution Control Agency (pers. comm., Ms. Kathy Svanda, Minnesota Pollution Control Agency, February 1980).

The Upper Mississippi River Basin Commission (1977) reported the following major problems in the subbasin: (1) inadequate streamflows in late summer, fall, and winter to assimulate wastes and to meet minimum streamflow requirements for recreational and environmental uses; (2) municipal and agricultural waste pollution; and (3) severe wind and water erosion damages to environmental resources (which may include water quality).

The subbasin is part of the Red River of the North, Segment 3 Wild Rice-Sand Hill Rivers as designated by the Minnesota Pollution Control Agency (1975). Although the Sand Hill River was not broken out specifically, except for point sources of pollution discussed later under Wastewater Management, water quality problems identified for the segment were frequent turbidity and fecal coliform violations and infrequent dissolved oxygen and ammonia violations. These problems may occur in the Sand Hill River, especially the ones associated with point sources of pollution. The Minnesota Pollution Control Agency (1979) listed sediment and nutrient source types and levels of contribution for Polk and Norman counties as follows: upland erosion--low to medium low; streambank erosion--medium low to medium; drainage ditch erosion--medium to high; gully and wind erosion--present; nitrogen--low to medium low; phosphorus--medium low; feedlots--medium low. The source types and contribution levels do not necessarily apply specifically to the subbasin, but possibly indicate

that streambanks, drainage ditches, and gully and wind erosion may contribute to sediment-related problems such as high turbidities. Nutrient inputs to nonpoint sources in the two counties do not appear to be significant.

Groundwater quality problems are related to excessive concentrations of iron, manganese, sulfates, and total dissolved solids (Upper Mississippi River Basin Commission, 1977; Minnesota Department of Health, 1977).

Water Supply Problems

With the exception of the Sand Hill River, there is little natural storage potential for surface water supplies in the subbasin. Groundwater contributions to the river are minimal in the western section because of the depth of silt and clay deposits. Test drilling is usually required in this area to locate water-yielding sand and gravel deposits.

Contacts with public officials of two of the largest towns in the subbasin, Fosston and Fertile, revealed no major problems with water supply from wells. Population increase is not expected to require the drilling of additional wells. The water quality is fairly good, although it generally ranges from hard to very hard.

Erosion Problems

Agricultural land within the subbasin is subject to moderate to severe sheet erosion because of uncontrolled water moving across the surface of the land. The action of uncontrolled water is exacerbated by unprotected ditches and lack of drop structures and similar protection devices. Wind erosion is prevalent throughout most of the subbasin, especially in the central and eastern sections, where the lighter, sandy soils are located. Windblown soil fills drainage systems and water courses and adds a large load of sediment to the stream flows. The added sediment severely decreases the water holding capacity of lakes and ditches. There are areas within the subbasin in which major drops of elevation occur through sandy soils, which contributes to soil erosion. One of these areas is approximately nine miles east to west through the city of Fertile.

Irrigation

Irrigation is being developed in the subbasin to provide more efficient crop production. Even when normal amounts of rainfall occur, a great

portion can be lost through runoff or deep percolation. The amount of irrigated acreage in the subbasin increased greatly between 1970 and 1975. The irrigated acreage is mostly in Polk County, which constitutes the major portion of the subbasin. The amount of irrigated acreage in Polk County increased from 60 acres in 1971 to 7,140 acres in 1975. The irrigated acres still represent a very small part of the total crop acreage.

The potential for increased irrigation is not known because information about the area's surficial sand aquifers has not been documented. At best, however, the subbasin is only moderately suitable for irrigation on the basis of soil types.

Wastewater Management

A total of three municipal and two industrial point sources are located in the subbasin. A listing of these dischargers, along with problems and treatment needs, is given in Table 3.

The community of Winger experiences problems with malfunctioning septic tanks. Winger is interested in constructing a system of collection sewers and a treatment facility but is ranked as 377 on the state's Municipal Needs List (MNL) and will not receive any funding from State-Federal grants for a number of years. The town is considering funding the facilities with their own monies and assistance from the FHA in the form of a grant. The Winger Cheese Company has closed down its operations; an NPDES permit will be required before it becomes operational in the future. Effluent data for the Rindal Co-op in 1973-74 indicated that average concentrations for BoD, TSS, and total coliforms were 12 mg/l, 43 mg/l, and 1100 MPN/1000 ml, respectively. The co-op was issued an NPDES permit in 1975 which will need to be complied with. Fertile operates a sewer system without a treatment facility, which will be required. The facility at Climax appears to meet effluent standards with the exception of TSS violations; however, this parameter should improve with better operation. The Kobber Meat Market and Minn-Kota Potato Storage Company discharge into the municipal system at Climax (Minnesota Pollution Control Agency, 1975).

Table 3

PROBLEMS AND TREATMENT NEEDS OF POINT SOURCE DISCHARGERS IN THE SAND HILL RIVER SUBBASIN

Discharger Description	Receiving Water	Discussion of Problems	Treatment Needs	Other Planning Considerations
Winger	Sand Hill River via a ditch	Inadequate treatment	Needs a facility; low on MNL list, not likely to receive funding in near future.	May desire to finance plant without grant moneys. Apply for NPDES permit 180 days prior to discharge.
Winger Cheese Company	Sand Hill River via a drainage tile and ditch	Inadequate treatment	Not known	Must apply for NPDES permit 180 days prior to discharge
Rindal Co-op Dairy Association	Sand Hill River	Excessive levels of BOD, TSS and Fecal Coliforms	Construct facilities to comply by 10/1/75	--
Fertile	Sand Hill River	No treatment	Facilities needed	Apply for NPDES permit 180 days before discharge--low on MNL.
Climax	Sand Hill River	Improved reporting needed. TSS level too high	Improve operation to reduce TSS	Interim standards apply until 4/30/77.

Source: Minnesota Pollution Control Agency, 1975.

Beltrami, an unsewered community, experiences problems with backups in drainfields and well contamination because of the high water table. Beltrami is seeking financial assistance from HUD to construct a sewer system (Minnesota Pollution Control Agency, 1975).

Hydropower

There are no hydropower facilities in the subbasin, and the topography and lack of natural water storage potential limit future development. Future hydropower development in Minnesota is expected to occur to the southeast of the Red River Basin, particularly in the Minneapolis-St. Paul area.

Public Perception of Problems and Solutions

The public's perception of problems and solutions in the subbasin is not completely defined in documents, partly because the Corps of Engineers has not held public meetings in this area. However, the subbasin has been organized as a watershed district.

The primary document for the identification of public perceptions is the Sand Hill River Watershed District's Overall Plan, prepared by the Minnesota Water Resources Board. Since the document was prepared by the managers with the assistance of an advisory panel, it is felt to be an adequate reflection of local interests and desires.

At that time, the primary needs identified for the subbasin were: fish and wildlife conservation, water supply, water quality, erosion control, and flood control. In 1958 the Corps of Engineers completed 20 miles of channel straightening, clearing, and enlarging of the Sand Hill River and Sand Hill Ditch. In 1978, a reconnaissance study was authorized to address a twofold problem: sloughing along the side slopes of the channel improvement and lack of excavated material on the left bank side of the channel, possibly aggravating flooding in the city of Beltrami.

Initiation and completion of the study in FY 1980 will bring additional information to light regarding the ultimate solution of this particular erosion and flood control problem. There are no other existing, planned, or authorized projects in the subbasin.

It may be inferred from these documents that the present public has an interest in similar measures, particularly those that would further reduce flooding and erosion problems and would further enhance conservation and wildlife values. Additional evidence for interest in flood control measures is contained in public hearings held in East Grand Forks in 1978 and 1979 before subcommittees of the Committee on Public Works and Transportation of the U.S. House of Representatives. From these documents, it is evident that residents of the Red River Basin consider flood control to be the primary water related need for the area and that they are interested in whatever solutions may be proposed by Federal, state, or local agencies.

IV. DESCRIPTION OF SUBBASIN RESOURCES

IV. DESCRIPTION OF SUBBASIN RESOURCES

This section of the report discusses the primary resource conditions within the subbasin that are water-related and that would be affected by a comprehensive water and related land resources plan centering on flood control measures.

Social Characteristics

The rapid decline in population in the subbasin prior to 1970 was the result of outmigration (as high as 11 percent annually). Agricultural employment decreased as mechanization on farms reduced the demand for farm laborers. There was also a lack of employment opportunities in other sectors, and many people left the subbasin to move to urban areas that provided greater economic security. During the 1970's, farm employment became more stable, and the loss of population was not as severe. The total population continued to decrease, however, but only from 6,992 in 1970 to 6,979 in 1977. The only county within the subbasin that lost population from 1970 to 1977 was Norman, which experienced both a natural decrease (more deaths than births) and a net out-migration rate of -2.2 percent. During the same period, Polk County's population increase was caused by a natural increase and a low in-migration rate of 1.6 percent. The population of Mahnomen County increased slightly, but the out-migration rate was three percent.

Fosston, with a population of 1,518, is the largest town in the subbasin. In addition to Fosston, the towns of Fertile (899) and Winger lost population between 1970 and 1977. Both Climax (300) and Beltrami (175) in the western part of the subbasin had an increase in population. The towns on the Sand Hill River include Climax, Beltrami, and Fertile.

The population density for the subbasin has remained stable at 14.4 persons per square mile during the 1970's. The population is primarily of Norwegian background in Polk and Norman counties and of German descent in Mahnomen County. The black minority population is too small to be identified. The White Earth Indian Reservation is included in the Mahnomen County sector of the subbasin; however, this is a sparsely populated area of the reservation.

All of the towns and the vast majority (92 percent) of the subbasin's population are in Polk County. Towns within the subbasin are primarily agricultural service centers. The communities are close-knit. Census data (1970) show that 76.1 percent of the residents in Polk County own their own homes. Sixty-five percent were living in the same residence as in 1965, and 81 percent were living in the same county. Seventy-four percent of the employed persons work in the county of residence (Polk).

Community cohesion and a sense of identity and common purpose with regard to flooding problems within the subbasin was strengthened by the formation of the Sand Hill River Watershed District.

Economic Characteristics

Employment

Farm employment in the subbasin decreased by more than 50 percent between 1940 and 1970. This was a result of mechanization and the move to large-scale farming. Employment in other sectors, primarily trade and services, registered moderate increases, but not enough to offset the decline in agricultural employment. Thus, an overall decrease in employment was experienced. Farm employment has now stabilized, and moderate increases continue in most other sectors. As a result, total employment between 1970 and 1977 increased from 2,587 to 3,151 (a 21 percent increase).

Unemployment in the subbasin fluctuated between seven and eight percent between 1970 and 1977. Although the unemployment rate is not one of the highest in the Northwest Region of Minnesota, the subbasin does have problems in this area. Norman County lacks adequate employment opportunities, and Polk County, which is more populated, has more unemployed people than any other county in the Region. The loss of even a few small industries in a sparsely populated area can have debilitating effects on the economic viability of individual communites.

Income

Total personal income for the subbasin increased from $34 million to $62 million between 1969 and 1977 (as expressed in 1979 dollars).

More than 60 percent of the total personal income is farm income, and cash grain sales account for at least 70 percent of the farm income. Average per capita income during the same years increased from $4,885 to $8,878, which was slightly above the 1970 average income figure of $8,314 for the whole state. Although there has been an upward trend in both total personal and per capita income, fluctuating farm prices are the primary determinants of income changes from year to year. Also, severe flooding can cause sharp declines in income, as in 1975.

Business and Industrial Activity

Agriculture

Agriculture is the predominant sector in the subbasin's economy, and the production of small grains is the most important agricultural component. Approximately 88 percent (or 272,589 acres) of the subbasin's land area is under cultivation, and another 3 percent is devoted to pasture. In the central and eastern portion of the subbasin, livestock activities and dairy enterprises are important.

The major crops grown in the subbasin are identified in Table 4. Wheat is the leading crop, accounting for almost 40 percent of the harvested acreage, followed by barley, sunflowers, sugarbeets, and hay (48 percent, collectively, of the harvested acreage). There are also minor acreages of oats, corn, potatoes, rye, flax, and soybeans. Of particular significance is the emergence within the past few years of sunflowers as a major crop in the subbasin.

Table 4

1978 CROP STATISTICS, SAND HILL RIVER SUBBASIN

Crop	Harvested Acres	Yield Per Acre	Total Production
Wheat	97,320	38.2 bushels	3,717,624
Barley	56,580	55.0 bushels	3,111,900
Sunflowers	25,490	1,616 pounds	41,191,840

Source: Gulf South Research Institute.

Cropping patterns in the floodplain of the subbasin are similar to those throughout the subbasin, but there is greater emphasis on specialty crops. In the western portion of the subbasin where the soil is fine-textured, deep, and dark, the most common crops are small grains, sugarbeets, sunflowers, and potatoes. In the central part of the subbasin, the principal crops grown are wheat, barley, and hay. The eastern end of the subbasin is characterized by coarser soils that grade into silt, very fine sand, and sand and gravel. The primary crops in this area are small grains, corn, and potatoes.

Two of the counties in the subbasin (Polk and Norman) have been the leading Minnesota counties in the production of wheat, barley, potatoes, sugarbeets, and sunflowers during much of the past decade.

Manufacturing

There are eight manufacturing establishments in the subbasin that are located in the towns of Beltrami, Climax, Fosston, and Fertile. Four of the manufacturers produce fertilizers, and two are involved in milk processing. The manufacturing establishments primarily support the agriculture industry and do not employ a large number of people. Table 5 presents the estimated manufacturing employment by two-digit Standard Industrial Classfication (SIC) code.

Table 5

MANUFACTURING ESTABLISHMENTS, SAND HILL RIVER SUBBASIN

SIC	Description	Estimated Employment
20	Food and Kindred Products	45
27	Printing and Publishing	40
28	Chemicals and Allied Products	40
TOTAL		125

Source: 1979-80 Minnesota Directory of Manufacturers

Trade

In 1977, total trade receipts for the subbasin exceeded $55 million (expressed in 1979 dollars). More than 65 percent (or $36.4 million)

of the receipts were wholesale trade. Retail trade and selected service receipts were $18.9 million and $2 million, respectively, in 1977.

Transportation Network

This subbasin is rural in nature and depends on its transportation network to move farm produce to market and receive services from the metropolitan areas. It is crossed from north to south by Federal Highways 75 (through Climax) and 59 (through Winger), and by State Highway 9 (through Beltrami) and 32, which passes through the town of Fertile. Highways 75 and 59 travel the entire length of the state and provide access to various other major arteries that connect to the metropolitan areas of Grand Forks (North Dakota), Sioux Falls (South Dakota), the Fargo-Moorhead area, the Port of Duluth, and Minneapolis-St. Paul. The major east-west route in the subbasin is Federal Highway 2, which travels through the town of Fosston. All the other major highways intersect this highway, which provides direct access to Crookston and Grand Forks west of the subbasin and to Bemidji, Grand Rapids, and Duluth east of the subbasin.

The subbasin is also traversed by five rail lines that parallel the major north-to-south highways. The four lines owned by the Burlington Northern Railroad pass through the towns of Climax, Beltrami, Fertile, and Fosston, and the Soo Line Railroad runs through the town of Winger. A natural gas pipeline crosses the subbasin near the town of Beltrami. There are also two airports within the subbasin located in Fosston and Fertile. These airports have limited facilities and handle mostly small aircraft.

Land Use

Approximately 88 percent of the subbasin is under cultivation, 5.4 percent is forest, and three percent is pasture. Marsh and water areas are quite small (1.7 percent, collectively) and are located in the southern portion of the subbasin. Urban development is minimal.

Land use in the floodplain of the Sand Hill River does not differ significantly from land use in the subbasin. The floodplain is an important agricultural area in the western and eastern parts of the subbasin.

The land in the west is nearly level, and almost all is cultivated. The eastern portion has gently rolling terrain with numerous potholes which have been drained. The central part of the subbasin has brush and scrub tree growth, wetlands, gravel ridges, and only marginal soils for agricultural crops. A great deal of the pasture lands are lcoated here.

Over the past decades, the subbasin has experienced increased agricultural production through intensive ditching, wetlands drainage, deforestation, and the utilization of marginally productive land. This trend is expected to continue in the future, but at a reduced rate.

Environmental Characteristics

Climate

Climatological data can be obtained from the U.S. Weather Bureau Station in Fosston. The average mean temperature is 10°F during the winter months and 68°F during the summer months. The average annual precipitation for the subbasin is 20.8 inches, with extremes varying from a minimum of 10 inches to a maximum of 34 inches. Approximately 75 percent of the annual precipitation falls during the period April through September. About 15 percent of the precipitation normally occurs as snow. Drought can be a problem in July and early August in the entire subbasin, especially in the center portion where the soils are thin and light. Rainfall is normally adequate in May and June for agricultural purposes. Heavy rainfall during the spring and early summer months contributes to flooding problems in the subbasin.

Geology

The subbasin lies within the Western Lake Section in the Central Lowland Province of the Interior Plains Division. Bedrock is predominantly undifferentiated Pre-cambrian igneous and metamorphic rock overlain by undifferentiated Cretaceous deposits in the western portion of the subbasin. Cretaceous sediments are generally fine-graned sandstone and interbedded shale.

Glacial deposits overlie bedrock and are from 150 to 250 feet thick. Features characteristic of glacial geology include level lands, beach ridges, and swamps which are represented by deep-water clay and silt lake deposits

in the west, sand and gravel lakeshore deposits in the central portion of the subbasin, and loam and sandy till in the east. The weathering of these deposits has contributed, in part, to the formation of fertile agricultural soils in the subbasin.

Biology

Native prairie once occupied most of the subbasin with the exception of the eastern portion, which was heavily timbered. Woodlands, in the form of gallery forests, originally occurred along streams and around lake perimeters. Now, however, most of the grasslands have been converted to cropland or pastureland, as has the woodlands. A few scattered prairie tracts remain where they have been maintained by haying and occasional fires or through protection given in such areas as the Agassiz Dunes Natural Area, which will be discussed further in the Significant Environmental Elements section. Major grass species occurring in these prairie remnants include big and little bluestem, switch grass, Indian grass, prairie cordgrass, and prairie dropseed. The principal forest types in the subbasin include elm-ash-cottonwood, aspen-birch, and maple-basswood. The elm-ash-cottonwood type is found as a floodplain community along the Sand Hill River (primarily at Climax) and in the area between Fertile and Winger. The aspen-birch type is located south of Fertile in Norman County along the southern boundary of the subbasin. The maple-basswood community is situated mainly around Union Lake and to the east of Rindal near the river. Predominant tree and shrub species in these types include the following: 1) elm-ash-cottonwood--American elm, green ash, cottonwood, hackberry, boxelder, silver maple, willow, and hawthorn; 2) aspen-birch--aspen, paper birch, snowberry, and red-osier dogwood; 3) maple-basswood--sugar and red maple, basswood, and yellow birch (Minnesota Water Resources Board, 1977; North Central Forest Experiment Station and Minesota State Planning Agency, no date; U.S. Fish and Wildlife Service, 1980; Wanek, 1967).

The principal wetland zones of the subbasin, as delineated by Mann (1979), are the Red River Valley Lake Plain, Galcial Lake Agassiz Beachlines, and Border-Transition. The lake plain zone is found in the nearly level western portion of the subbasin, which was the bed of Glacial Lake Agassiz.

Shallow wetlands and native prairie once occurred in this zone but have been converted almost totally to agricultural lands. The glacial beachline zone extends through the central region in an area from six miles west to three miles east of Fertile. Shallow wetlands, gravel ridges, brush and shrub tree growth, and marginal soils for crops characterize this zone; a substantial amount of land is in pasture. The Border-Transition zone constitutes the remainder of the subbasin to the east, which contains potholes, marshes, tracts of timber, and agricultural lands. Most of the potholes have been drained. Wetland types probably occurring in the subbasin include Type 1--seasonally flooded basins or flats; Type 3--inland shallow fresh marshes; Type 4--inland deep fresh marshes; Type 5--inland open fresh water; Type 6--shrub swamps; and possibly some type 7--wooded swamps (Minnesota Water Resources Board, 1977; U.S. Fish and Wildlife Service, 1980).

Important wildlife habitats in the subbasin are the remaining grasslands (particularly the Agassiz Dunes Natural Area), woodlands, and wetlands. The prairie remnants are valuable habitats for those species such as the rare greater prairie chicken that utilize wholly or in part grassland ecosystems. The woodlands and brushy areas are significant as breeding, nesting, feeding, and resting areas for both migratory and resident wildlife. Where they are contiguous in a linear fashion along streams, they provide a travel corridor through disturbed (e.g. cropland) areas. The forested areas afford habitats for a greater variety of wildlife than any other major habitat type in the subbasin. Wetlands, including potholes, marshes, and open waterbodies, provide excellent habitats for aquatic and terrestrial biota. Organisms utilizing these areas include fishes, various aquatic invertebrates, waterfowl, big and small game, furbearers, some rodents, wading birds, and many species of songbirds (U.S. Fish and Wildlife Service, 1980).

The white-tailed deer is the major big game animal in the subbasin; in 1978 the following harvests were reported from the subbasin's counties: Polk--463, Norman--223, Mahnomen--183. Some moose occur, as well as the possibility of low black bear populations (three were harvested from Mahnomen County in 1978). Typical furbearers include the red and gray fox, mink, muskrat, beaver, and raccoon. Small game mammals consist of the cottontail, jackrabbit, and gray squirrel. Upland game girds are composed of the ruffed

grouse, some pheasant (<5/100 miles) and Hungarian partridge, and sharp-tailed grouse (0.5 to 6 adult males/square mile) in scattered flocks. Waterfowl production occurs in the wetlands, with the most common breeding ducks consisting of the mallard, blue-winged teal, and northern shoveler. Geese and other migratory birds heavily utilize the stubble fields of the subbasin during the fall. A total of 101 species of breeding birds have been reported from the region encompassing the subbasin (Region 1N or the Minnesota DNR, which includes Kittleson, Roseau, Marshall, Polk, Pennington, Red Lake, Norman and Mahnomen counties): non-native pest birds--three species; non-native game birds--one species; native game birds--10 species, and native nongame birds--87 species. Common nongame breeding birds are the killdeer, house wren, robin, and savannah sparrow. Twenty species of amphibians and reptiles have been identified in the three counties of the subbasin. Typical herpetofauna include the western plains garter snake, red-bellied snake, eastern tiger salamander, and wood frog. Twenty-one species of nongame mammals have been reported from the three-county area of the subbasin, with common species composed of the coyote, Richardson's ground squirrel, deer mouse, and meadow jumping mouse (Henderson, 1978, 1979; Henderson and Reitter, 1979; literature cited in Mann, 1979; U.S. Fish and Wildlife Service, 1980).

The Sand Hill River originates at Sand Hill Lake, south of Fosston. For about the first six miles of these headwaters, the elevation drops approximately 120 feet; then begins a more gentle slope until a point about 3 miles east of Fertile. For the next nine miles, there is a major drop in elevation of nearly 300 feet. After this sharp decrease in elevation, the rest of the subbasin is nearly level.

Because of the level topography, a channel improvement ditch, the Sand Hill River State Ditch, was constructed by the Corps of Engineers in 1954 for aid in flood control. This ditch, which begins above the confluence of Sand Hill River and Kittleson Creek, runs westerly for about 18 miles. Numerous other similar county ditches are located in the western and extreme eastern portion of the subbasin. Channelization has caused a decrease in cover and spawning habitats which are favorable to game fish. Additionally, effluent from industries, municipalities, and agricultural

operations has degraded the water quality to such a degree that the Minnesota Department of Natural Resources has classified the Sand Hill River as a rough fish, forage fish (Class IV) stream. This designation describes the stream as having fish populations that are dominated by rough or forage fishes such as carp, suckers, and minnows. A few northern pike are known to migrate upstream into the eastern portions of the subbasin during high water (U.S. Fish and Wildlife Service, 1979; Minnesota Water Resources Board, 1977).

Eight species of live mussels were reported by Cvancara (1970) to inhabitat the Sand Hill River. These species were Fusconaia flava, Lasmigona compressa, Lasmigona complanta, Anodonta grandis, Anodontoides ferussacianus, Strophitus rugosus, Lampsilis sisiquoidea, and Lampsilis ventricosa. One mussel, Ligumia recta latissima, was reported by empty shells only (U.S. Fish and Wildlife Service, 1979).

The fish and game lake resources of Norman, Polk, and Mahnomen counties are listed, by lake type, in Table 6.

Water Supply

Water supply is obtained exclusively through groundwater sources, and all of the towns rely on wells for their municipal and private water supplies. Aquifers are located primarily in the beach ridge and till areas. The two wells in Fertile have an average depth of 150 feet and an operating rate of 150 and 125 gpm. The most current figures from the Minnesota State Health Department show an approximate consumption rate of 36,500,000 gallons per year. The town also has one stand-by well. The largest city in the subbasin, Fosston, receives its water from deep wells in the till area. Fosston's current annual water usage is approximately 65,700,000 gallons. Water hardness is common throughout the subbasin; however, aquifers in the west yield softer water than those in the morainal area. Groundwater is not used for irrigation purposes, but some farmers do use the Sand Hill River for irrigation.

Water Quality

Water uses in the Sand Hill River consist of fisheries and recreation, industrial consumption, agriculture and wildlife, and other uses such

Table 6

FISH AND GAME LAKE RESOURCES, BY LAKE TYPE, IN THE COUNTIES INCLUDED IN THE SAND HILL RIVER SUBBASIN

	County					
	Norman		Mahnomen		Polk	
Type	Number	Acres	Number	Acres	Number	Acres
Dry Lake Basins[1]	-0-	-0-	4	262	5	143
Game Lakes[2]	5	144	188	7,326	227	7,336
Marginal Lakes[3]	-0-	-0-	57	5,413	87	8,919
Fish and Game Lakes[4]	-0-	-0-	-0-	-0-	-0-	-0-
Fish Lakes[5]	-0-	-0-	10	----	5	----
Unclassified Lakes[6]	-0-	-0-	5	1,466	5	600
Centrarchid Lakes[7]	-0-	-0-	2	1,520	-0-	-0-
Walleye Lakes[8]	-0-	-0-	2	1,567	-0-	-0-
Trout Lakes[9]	-0-	-0-	-0-	-0-	-0-	-0-

[1]Dry lakes as reported here include those basins that do not have standing water throughout the year. This includes drained lake basins, dry basins with emergent vegetation such as cattails, and shrub swamps.

[2]Game lakes are those lakes shallower than six feet which ordinarily contain water throughout the years. They are ordinarily designated as being Type III or Type IV marshes.

[3]Marginal lakes are those that range from six to 20 feet deep, winterkill, and frequently have rough fish populations. Lakes with inlets are most likely to have rough fish populations.

[4]Fish and game lakes are defined as lakes in which both the game and fish resources are of major importance. These are lakes with several distinct connected basins, some river lakes, impoundments (especially the navigation pools on the Mississippi River), and the northern pike--wild rice--waterfowl lakes.

[5]Fish lakes are those that do not winterkill and have maximum depths that are ordinarily more than 20 feet and average depths that are 10 feet or more. Some soft water lakes, however, have average depths less than 10 feet and do not waterkill, and some fertile shallow lakes have inflows of water that add sufficient oxygen to prevent winterkill.

[6]Unclassified fish lakes are those where sufficient information is available to determine that they do not winterkill and are definitely fish lakes, but data available does not justify further classification. This category also includes a few lakes that do not readily fall into the remaining categories. For example, rough fish lakes that do not winterkill.

[7]Centrarchid lakes are those having fish populations that are primarily composed of bluegills, pumpkinseed, crappies, rock bass, largemouth bass, and/or smallmouth bass. These lakes frequently have good populations of northern pike. Some of these lakes contain populations of walleye that are either artificially maintained or are a natural population that is a small fraction of the total fish population. In the northeastern part of the state smallmouth bass and rock bass tend to be the most important segments of a centrarchid population in a lake. Crappies and green sunfish are the centrarchids that occur most commonly in very eutrophic southern lakes.

[8]Walleye lakes are those having walleyes, yellow perch, common suckers, northern pike, and frequently tullibee as the main constituents of the fish population. Sometimes these lakes have fair sized populations of centrarchids, but they tend to be restricted to protected areas such as shallower weedy bays.

[9]Trout lakes are those containing known populations of trout, either naturally or maintained by stocking.

Source: Peterson (1971).

as receiving waters for waste effluents, fire prevention, etc. The subbasin is situated in a segment that has been classified as Effluent Limited, which means that significant reaches of the stream in the segment have flow at all times to ensure that water quality standards will be maintained after secondarily (or best practicable) treated effluents have been discharged into the waters (Minnesota Pollution Control Agency, 1975).

Major water quality problems that have been identified within the subbasin, or possibly occur, include municipal and agricultural waste pollution, severe wind and water erosion damages to environmental resources (possibly including water quality), frequent turbidity and fecal coliform violations, and infrequent dissolved oxygen and ammonia violations. These problems were described in the Problems and Needs section. The Upper Mississippi River Basin Commission (1977) reported that streamflows were inadequate in the subbasin during late summer through winter to assimilate wastes and to meet minimum streamflow requirements for recreational and environmental uses. This statement is in disagreement with information presented by Winter et al. (1970), which indicated that the flow in the Sand Hill River mainstem was sufficient to support uses such as municipal and industrial supply, rural domestic and stock supply, and irrigation supply except during years of extreme drought. The U.S. Geological Survey (1979) stated that the average discharge of the Sand Hill River at Climax over the last 32 years (1947-79) has been 70.5 cfs, with extremes ranging from 4,560 cfs in April 1965 to 1.0 cfs in January 1962.

Water quality data is deficient for the Sand Hill River, as was pointed out above in the Problems and Needs discussion. The only data found were some very general statements by Winter et al. (1970), which indicated that total dissolved solids in the river and lakes and potholes of the subbasin was mostly less than 500 mg/l, and that hardness is greater than 180 mg/l in the lakes and potholes and in the river at low flow.

Table 7 gives groundwater quality data for the communities of Climax, Fertile, Winger, and Fosston. These data show that the water is characteristically hard, with either high or excessive concentrations of total dissolved solids. With the exception of Climax, every community has at least one well with excessive levels of iron and manganese. The two wells at Winger also have problems with sulfates.

Table 7

GROUNDWATER QUALITY DATA[a] FROM COMMUNITIES IN THE SAND HILL RIVER SUBBASIN

Parameter	Criteria[b]	Climax			Fertile			Winger			Fosston		
Sample Date		1-68	3-70	8-59	8-59	10-65	1970	4-49	6-61	1-76	11-68	2-75	7-73
Well Depth		141	141	131	160	150	144	204	205	220	270	276	278
Total Hardness	--	420	410	300	340	320	300	600	530	350	350	330	30
pH	5-9	7.6	7.2	8.0	7.8	--	--	7.8	7.4	7.6	7.3	7.3	8.9
Iron	0.3 mg/l	0.13	0.05	0.88	1.30	0.92	0.87	3.0	2.7	2.0	1.6	0.79	0.09
Manganese	0.05 mg/l	<0.01	0.02	0.16	0.18	0.22	--	0	<0.05	0.07	0.02	0.11	0.01
Chloride	250 mg/l	3.3	<0.01	1.3	2.5	2.7	--	1.0	2.5	0.8	2.0	1.3	33
Sulfate	250 mg/l	18	22	57	70	60	50	260	330	<5.0	<5	6.2	5.0
Fluoride	1.5 mg/l	0.62	0.52	0.18	0.25	0.14	--	0	0.10	0.18	0.15	0.18	0.9
Nitrate Nitrogen	45 mg/l	1.1	1.2	<1	<1	<1	--	3.0	<1	<1	<1	<1	<1
Total Dissolved Solids	500 mg/l	690	700	--	--	440	--	--	--	310	400	300	490

[a]All chemical data expressed in mg/l(ppm).

[b]From Minnesota Department of Pollution Control (1975) and/or U. S. Environmental Protection Agency (1976).

Source: Minnesota Department of Health, 1977; Winter et al., 1970.

Aesthetics

The western section of the subbasin is primarily level terrain that has been cleared for agriculture. However, the gently rolling hills of the central and eastern portion of the subbasin provide areas of topographical relief. There are a number of wildlife management areas in this portion of the subbasin with wooded areas that provide habitat for a variety of wildlife species and offer scenic beauty.

Union Lake and Lake Sarah, on the northern border of the subbasin, and Sand Hill Lake in the southeastern corner have stimulated the creation of private residences, parks, and campgrounds.

The Agassiz Dunes Natural Area, a 417-acre tract two miles southwest of Fertile, has been included in the Minnesota System of Scientific and Natural Areas. The dunes formed the shoreline of Glacial Lake Agassiz over 10,000 years ago. The area contains examples of shoreline fossils and unique prairie flora and fauna that have disappeared from many areas of the subbasin. Wilderness Municipal Park, comprising 700 acres, is associated with the dunes area and constitutes a substantial area of ecological diversity offering recreational and aesthetic opportunities to the residents of Fertile and other nearby communities.

Cultural Elements

Substantive evidence of early (Paleo) man in the subbasin is limited. Much of the glacial Lake Agassiz plain was poorly drained, swampy, and inhospitable to potential inhabitants as late as 9900 B.C. Significant archeological resources here, as elsewhere in the Red River Valley, are likely to be found along the former shores of Lake Agassiz (Strandlines) that bisect the subbasin. Other high-probability areas include bluffs along the Sand Hill River and the eastern upland areas of the subbasin with their numerous potholes and lakes.

To date, there are only 6 recorded archeological sites in the subbasin. Of these, half have Woodland components, and one of these three is representative of a late prehistoric culture called the Arvilla Complex (Wedel 1961:226; Johnson, 1973).

Archeological/historical sites are often associated with major streams. This fact could have significant impacts on the development and implementation of flood control measures. Archeological surveys of specific flood control measures would be necessary to fully assess the impact on cultural resources.

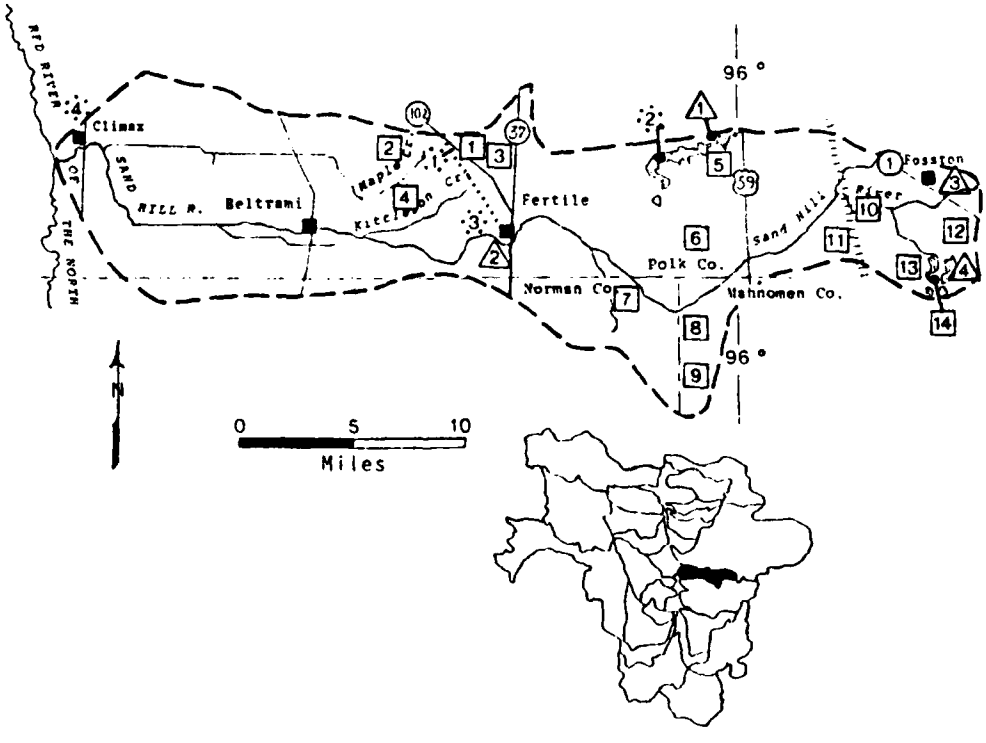
Historically, the subbasin and vicinity was inhabited by related tribes of the Siouan language family (Dakota-Sioux) that dominated Minnesota during the seventeenth century. The Chippewa, members of the eastern Algonkian family, thrust southward and westward into Minnesota to challenge this dominion. By 1820, the Chippewa-Ojibwa controlled the upper Red River Valley and the territory north of a boundary established by the treaty of 1825 (Hewes 1948:49; Blegen 1963:128-129).

The tempo of Euro-American settlement in the subbasin increased after the Civil War as settlers pushed west to the Red River Valley. A significant portion of the subbasin population is of German and Norweigan descent. The only recorded historical site in the subbasin is the Fertile Grist Mill. The lack of recorded archeological and historical sites is probably indicative of a lack of systematic investigation; systematic archeological and historical surveys should substantially improve the inventory of cultural resources.

Recreation Resources

Although there are a few significant lakes in the eastern part of the subbasin, recreation resources are limited in the western portion by the lack of large water bodies. Hunting is a popular activity throughout the subbasin, as evidenced by the 14 wildlife management areas comprising approximately 9,376 acres or 89 percent of total recreation lands. In addition, there are 12 Federal waterfowl production areas within the subbasin that are open to the public for hunting. Dear, moose, ducks, and geese are hunted. Furbearing species include muskrats, beaver, raccoons, and mink. The existing waterways and marshes provide valuable wildlife habitat.

Recreation areas are depicted in Figure III. A listing of wildlife management areas and an inventory of subbasin recreation sites larger than 15 acres is included in Appendix B of this report. Recreational areas over 15 acres account for 99.5 percent of the subbasin's recreation resources and include 406 acres of privately-owned sites and 715 acres of county and municipal parks.



☐ EXISTING WILDLIFE AREAS

1 Burham
2 Chicog
3 Godfrey
4 Liberty
5 Onstad
6 Rindal
7 Ranum
8 Bejou
9 Dittmer
10 Castor
11 Kroenig
12 Hovland
13 La Voi
14 Hasselton

Source: Minnesota Department of Natural Resources, Bureau of Planning Northwest Regional Development Commission.

Figure III. RECREATIONAL RESOURCES

The towns of Fosston, Gully, Winger, and Climax have small school athletic fields that provide limited non-water based recreational opportunities for residents of the subbasin.

The subbasin is included in the Minnesota Region 1 planning area. The 1979 SCORP (Draft) lists hunting, cross-country skiing, and snowmobiling areas as winter recreation needs; however, needs for summer recreational pursuits, including camping, fishing, swimming, and bicycling, are considered higher priorities for development.

There are several proposed recreation sites within the subbasin, including the following: (1) the Pembina Trail, traversing Kittson, Marshall, Pennington, Red Lake, Polk, and Norman counties; (2) a forty-acre area at Climax to be used for hiking and nature interpretation; and (3) 140 acres at Union Lake to be developed for camping, swimming, picnicking, and hiking. The most significant proposed area is the Fertile Wilderness Sanctuary, which would consist of 500 acres of sand dunes and a heavily wooded area at the original mill site on Sand Hill River and would provide additional water-related recreational opportunities in the subbasin.

Significant Environmental Elements

Social

Fertile and Fosston are the population centers of the subbasin. Fosston is located in the upland area and, for the most part, is not subject to flooding problems. The town of Fertile is in the Sand Hill River floodplain. Beltrami and Climax, located in the western portion of the subbasin, experience periodic flooding.

The Corps of Engineers completed 20 miles of channel improvements on Sand Hill River and Sand Hill Ditch near Beltrami in 1958 to control flooding problems. This project is currently being studied for possible modifications. Flooding in the subbasin results in damages to railroads and transportation arteries, causing delays and excessive repair costs, and to low-lying residential areas in the towns. About 75 percent of the floodplain is in cultivation and is adversely affected by flooding through the loss of topsoil and inherent fertility, damage to crops and equipment, and delays in planting.

Cultural

Only six archeological sites and one historic site have been recorded in the subbasin. The region promises a significantly larger inventory of cultural resources that could be discovered through more systematic study.

Soils

Soils in the subbasin are varied. The western portion is covered with level, calcareous, lacustrine deposits. These soils are dark colored and poorly drained, ranging from clays to silty clay loams. They are very productive but have problems with internal and external drainage and wind erosion. Proceeding eastward, the soils become progressively coarser, grading into silt, very fine sand, and finally sand and gravel. Soils in the central portion experience wind erosion and drainage problems, and, because of the low moisture-holding capacity in certain areas, drought can also be a problem. The eastern section contains numerous types of soils, most of which are loams. These soils are subject to the same problems and additionally have a complex relief pattern that ranges from gently sloping to extremely steep hillsides. Excessive lime content is a prevalent problem in scattered areas throughout the subbasin. This may retard plant growth and result in reduced yields.

Water

Only 1.4 percent of the subbasin's land area is water. The Sand Hill River is the major river in the subbasin, and there are also a few small creeks. The north-central and eastern portions of the subbasin contain a number of small lakes that are important to recreation, water supply, and fish and wildlife.

Woodlands

The woodlands and brushy areas of the subbasin are important because of their value for wildlife habitats and because of their limited areal extent. Data supplied by the Minnesota Land Management Information Service (MLMIS) indicate that approximately 5.4 percent of the subbasin is forested; the major portion of the remaining area is in disturbed uses such as cultivated lands. Table 8 shows comparisons between percentages of woodland vegetation in 1969 and 1977 in the subbasin's three counties. Increases can be noted

Table 8

COMPARISON OF COUNTY PERCENTAGES OF WOODLAND VEGETATION BETWEEN 1969 AND 1977

County	Percentage of County Containing Woodland Vegetation		Change in Percent Composition
	1969	1977	
Polk	5.1	6.7	+1.6
Norman	4.6	5.1	+0.5
Mahnomen	33.4	32.5	-0.9

Source: Minnesota Land Management Information Service (in U.S. Fish and Wildlife Service, 1980).

in Polk and Norman counties, with a decrease of nearly one percent in Mahnomen County. The data indicate that a slight increase in wood vegetation is probably occurring in the subbasin. Reasons for this increase include establishment of shelterbelts and windbreaks by local landowners around homesteads and near tributary streams, abandonment of some upland farmlands with subsequent successional advancement, and revegetation of areas in the lower reaches of the floodplain that have not been cultivated in recent years (U.S. Fish and Wildlife Service, 1980; Minnesota Water Resources Board, 1977).

Wetlands

Wetlands are deemed significant because of their many beneficial uses and values such as groundwater recharge, floodwater retention, nutrient entrapment, habitats for flora, and waterfowl production (Cernohous, 1979; U.S. Fish and Wildlife Service, 1980; E.O. 11990, 24 May 1977). Data from the MLMIS show that 0.3 percent of the subbasin's total area is comprosed of marshes. Table 9 presents 1964 wetland data for Types 1 and 3-5 in Polk and Mahnomen counties; Norman County was not included in this inventory. The 1964 data represents a 25 percent sampling. All numbers except for Type 1 have been multiplied by four to give 100 percent values for numbers and acreages of wetlands. Type 1 wetlands were not measured in the 1964 survey; however, previous studies have

Table 9

1964 WETLAND INVENTORY DATA FOR TWO OF THE THREE COUNTIES IN THE SAND HILL RIVER SUBBASIN

	Wetland Types[a]									
	1		3		4		5		Total	
County	Number[b]	Acres[c]	Number	Acres	Number	Acres	Number	Acres	Number	Acres
Polk	1,721	2,718	2,097	5,340	537	5,251	234	7,526	4,589	20,835
Manhomen	1,848	2,319	2,776	10,975	186	1,973	118	2,509	4,928	17,776
TOTAL	3,569	5,037	4,873	16,315	723	7,224	352	10,035	9,517	38,611

[a]Type 1 = Seasonally flooded basins or flats.
Type 3 = Shallow fresh marshes.
Type 4 = Deep fresh marshes.
Type 5 = Open fresh water.

[b]Calculated at 60 percent of total wetland numbers.

[c]Calculated at 15 percent of total wetland numbers.

Source: U.S. Fish and Wildlife Service, 1980.

indicated that they comprise about 10-15 percent of total wetland acres and 60 percent of total wetland numbers in the Prairie Pothole Region. This information was used to calculate Type 1 estmates.

Table 10 shows wetland numbers and acreages for 1974; this sampling represented a 100 percent inventory and included Norman County. In addition to the wetland types surveyed in the 1964 investigation, exclusive of Type 1 wetlands, Types 6 and 7 and stockponds are also given. Table 11 shows a comparison of the 1964 and 1974 wetland inventory data for Types 3-5. These data are comparable, since methods used in the 1974 survey allowed direct comparison of the same sampling locations at the 25 percent level sampling. These data show that wetland numbers and acreages in 1974 have been reduced by 1,281 and 5,899, respectively, from 1964 totals (based on values multiplied to 100 percent from a 25 percent sampling).

Waterfowl Production Areas

Waterfowl Production Areas (WPAs) are wetland areas that the U.S. Fish and Wildlife Service (USFWS) has either acquired through fee title or obtained an easement interest on to preserve valuable breeding, nesting, and feeding habitat for migratory waterfowl. These wetland areas are purchased, or an easement interest obtained, with funds received from the sale of migratory bird hunting and conservation stamps (Duck Stamps). These WPAs are significant because they provide the public with a great variety of wildlife-oriented recreational opportunities as well as providing valuable habitat for migratory waterfowl and many other forms of wildlife. The USFWS is responsible for the compatibility determinations (uses) and the issuance or denial of permits involving these lands. The approximate locations of these WPAs (fee tracts) within the subbasin are shown in Figure IV. Total acreages of these WPAs (fee and easement) within Polk and Mahnomen counties, Minnesota are given in Table 12.

Wildlife Management Areas

A total of 14 wildlife management areas are found within the subbasin. A list of these areas and their acreages and location were presented in the Existing Conditions section for recreation. These areas are considered significant because of the opportunities provided for outdoor recreation and the protection and management given to biological resources within their confines.

Table 10

1974 WETLAND INVENTORY DATA FOR THE THREE COUNTIES
IN THE SAND HILL RIVER SUBBASIN

	Wetland Type													
	3		4		5		6		7		Stock Ponds		Total	
County	Number	Acres	Number	Acres	Number	Acres	Number	Acres	Number	Acres	Number	Acres	Number	Acres
Polk	1,437	8,413	438	4,138	351	15,745	416	4,277	4	40	146	--	2,787	32,613
Norman	389	2,158	177	1,636	4	¼	50	1,610	1	100	21	2	642	5,540
Mahnomen	1,504	9,919	261	5,054	130	9,206	46	477	2	25	144	--	2,087	24,681
TOTAL	3,325	20,490	876	10,828	485	24,985	512	6,364	7	165	311	2	5,516	62,834

Source: U.S. Fish and Wildlife Service, 1980.

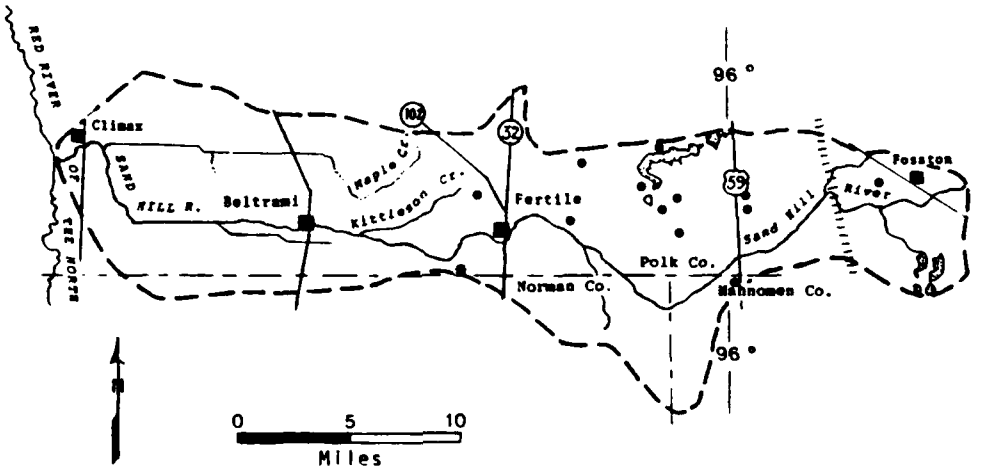
Table 11

COMPARISON OF 1964 AND 1974 WETLAND INVENTORY DATA SHOWING NUMBER, ACREAGE, AND PERCENT CHANGES FOR TWO OF THE THREE COUNTIES IN THE SAND HILL RIVER SUBBASIN*

	Wetland Type															
	3				4				5				Total			
County	Number	Percent	Acres	Percent	Number	Percent	Acres	Percent	Number	Percent	Acres	Percent	Number	Percent	Acres	Percent
Polk	259	-12.4	+111	+2.1	-18	-3.4	1,392	-26.5	-20	-8.5	-179	-2.4	297	-10.4	-1,458	-8.0
Mahnomen	830	29.9	3,136	-23.6	-66	-35.5	+291	+14.7	-88	-74.6	-1,596	-63.6	-984	-31.9	-4,441	-28.7
TOTAL	-1,089		-3,021		-84		-1,101		-108		-1,775		-1,281		-5,899	

*Represents values multiplied to 100 percent from a 25 percent sample.

Source: U.S. Fish and Wildlife Service, 1980.



• SCIENTIFIC AND NATURAL AREA
(Portion of the Agassiz Dunes Tract)

● WATERFOWL PRODUCTION AREAS (Fee Tracts)

Source: The Nature Conservacy (no date); Miles and Yeager (1979); U. S. Fish and Wildlife Service (1980).

Figure IV. WATERFOWL PRODUCTION AREAS AND SCIENTIFIC AND NATURAL AREAS WITHIN THE SAND HILL RIVER SUBBASIN

Table 12

ACRES OF FEDERAL WATERFOWL PRODUCTION AREAS (FEE AND EASEMENT) IN TWO OF THE THREE COUNTIES* OF THE SAND HILL RIVER SUBBASIN

County	Purchased Acres	Agreement Easement or Leased (Acres)	Total Acres
Mahnomen	4,520	4,262	8,782
Polk	7,444	672	8,116
TOTAL	11,964	4,934	16,898

*Norman County has no Waterfowl Production Areas.

Source: Annual Report of Lands Under Control of the U.S. Fish and Wildlife Service as of September 30, 1978. U.S. Department of the Interior, Division of Realty, Washington, D.C.

Threatened or Endangered Species

Two bird species that occur in the subbasin area are listed as being threatened and endangered species. The Arctic peregrine falcon breeds in the tundra area of Arctic Alaska, Canada, and Western Greenland and is therefore considering only a winter resident or migrant in the subbasin. The reduction of the peregrine populations is a result of DDT derivatives that cause thinning of the peregrine's egg shells. The second endangered bird species is the bald eagle. A peripheral nesting range is located in Mahnomen County. The Eastern timber wolf, an endangered mammal species, has its peripheral range in Polk and Mahnomen counties. Pressures caused by civilization seem to be the major reason for the wolf's decline in population (U.S. Fish and Wildlife Service, 1979).

Other Important Species

Four nongame mammals of special interest are located within the subbasin: (1) long-tailed weasel, (2) spotted skunk, (3) plains pocket mouse, and (4) American Elk. Reports are needed on the distribution and abundance of the long-tailed weasel and spotted skunk since they are now considered to be only peripheral species. The American Elk is a peripheral species that has been extirpated throughout most of Minnesota. The plains pocket mouse is of special interest because it is known only

from Northwest Minnesota (Region 1N). H.L. Gunderson and J.R. Beer reported seeing the plains pocket mouse in Polk County in 1953 (Henderson and Reitter, 1979; Henderson, 1979).

The great blue heron was reported in the region (Region 1N) during the 1978 breeding bird survey. The relative abundance of the great blue heron was estimated as one bird per 100 miles. The great blue heron is a species of special interest because of reductions in its nesting habitats (such as coniferous swamps), although presently it is not apt to become endangered. The marsh hawk and Franklin's gull are species of changing or uncertain status that occur in the area. These are presently uncommon or local but could become threatened. However, the marsh hawk presently appears to be increasing its populations. The eastern greater sandhill crane, considered a threatened species, was reported to be breeding during the 1978 survey (Henderson, 1979; Mo .e, 1974). No colonial bird nesting sites were reported by the Minnesota Department of Natural Resources (1978) in the counties included in the Sand Hill River Subbasin.

The smooth green snake requires a moist, grassy habitat that generally occurs is meadows or plains. Because of the scarcity of this habitat type. the smooth green snake has become a species of special interest. Although the smooth green snake was reproted in all three counties of the subbasin, more studies are needed to determine its relative abundance and distribution. The Canadian toad and great plains toad, both recorded from the subbasin, are of special interest because they are western species living near the eastern extremes of their ranges.

Natural Areas

Agassiz Dunes is the only natural area located within the subbasin. It is a 417-acre tract of land situated on the "Fossil Shoreline" of Glacial Lake Agassiz. A small portion of this area is located in the Wild Rice-Marsh Rivers Subbasin. Some of the plants found in the area include creeping juniper, grama grass, pasqueflower, basswood, cottonwood, and bur oak. The border of the prairie-forest communities merges some eastern and western animal species such as the small pocket gopher, western kingbird, upland plover, and lark sparrow (The Nature Conservancy, no date). Figure IV above shows the location of the Agassiz Dunes.

V. FUTURE CONDITIONS

V. FUTURE CONDITIONS

The following description of the subbasin's "most probable" and "without project" future conditions and resources focuses on economic aspects, population projections, and generalized environmental conditions and resources.

Most Probable Economic Conditions

According to the Principles and Standards, specifications of future conditions should reflect OBERS Series E and E' projections as a basis, unless conditions unique to the study area dictate that OBERS may not be totally satisfactory. Projections of general economic and demographic indicators for the non-SMSA portions of the Grand Forks area appear to be underestimated, since they project steady decreases throughout the study period. Therefore, state, regional, and Gulf South Research Institute (GSRI) developed figures have been adopted as most probable. OBERS E and E' projections have, however, been designated as most probable for per capita income and future agricultural activities.

Data presented in Table 13 depicts population, employment, and per capita income (expressed in 1979 dollars) figures. These figures reflect the slow reversal during the past decade of historic population and employment decline trends. This reversal has resulted largely from the stabilization of agricultural employment. Per capita income is forecast to rise at the rate set for the non-SMSA portion of the Bureau of Economic Analysis (BEA) area; i.e., some three percent per annum. The Northwest Regional Development Commission did not identify the towns of Beltrami, Climax, Fosston or Fertile as potential growth centers in the region. In fact, data indicate that the role of these communities within northwestern Minnesota's predominantly agricultural economic base is diminishing.

Most Probable Agricultural Conditions

Roughly 273,000 acres within the subbasin are currently under cultivation, and wheat, barley and sunflowers are the principal crops. The estimated value of the total production of these principal crops for 1980 (using

Table 13

SAND HILL RIVER SUBBASIN, POPULATION, EMPLOYMENT, AND PER CAPITA INCOME PROJECTIONS, 1990-2030

Parameter	Year							
	1970	1977	1980	1990	2000	2010	2020	2030
Population	6,992	6,979	7,100	7,400	8,000	8,200	8,400	8,500
Employment	2,587	3,141	3,200	3,300	3,600	3,700	3,800	3,900
Per Capita Income (1979 Dollars)	$4,885	$8,878	$10,700	$14,400	$19,500	$26,300	$35,500	$48,000

Source: U. S. Water Resources Council, 1972 OBERS Projections, Series E; Northwest Regional Development Council; Gulf South Research Institute.

October 1979 Current Normalized Prices for Minnesota) is $21.2 million. Projections of total production through 2030 for the principal crops is presented in Table 14. The projected total production for 2030 represents a value of $35.5 million, using October 1979 Current Normalized Prices for Minnesota.

Evaluation of Flood Damages--Future Conditions

A summary of present and future average annual flood damages is presented in Table 15. Assuming a discount rate of 7 1/8 percent, average annual damages throughout the projection period are expected to be $348,800.

Flood damages to residences, businesses, industrial structures, churches, schools, automobiles, house trailers, public property and contents are included in the urban damages category. Damages to streets and utilities (including water, gas, electricity, sanitary sewers, storm sewers, and telephone systems) are also taken into consideration. This category also includes loss of wages, loss of profits, expenditures for temporary housing, cleanup costs, and extra expenses for additional fire and police protection and flood relief.

Table 14

SAND HILL RIVER SUBBASIN, PRINCIPAL CROPS
AND PROJECTED PRODUCTION, 1980-2030
(Production in Thousands)

Year	Wheat (Bushels)	Barley (Bushels)	Sunflowers (Pounds)
1980	3,829	3,205	42,428
1990	4,442	3,718	49,216
2000	5,054	4,231	56,004
2010	5,437	4,551	60,247
2020	5,820	4,872	64,490
2030	6,433	5,385	71,278

Sources: OBERS Series E'; and Gulf South Research Institute.

Table 15

SAND HILL RIVER SUBBASIN, SUMMARY OF PRESENT AND FUTURE AVERAGE ANNUAL DAMAGES
URBAN, AGRICULTURAL, AND TRANSPORTATION
(October 1979 Prices, 7 1/8 Percent Interest)

Category	Flood Damages						Increase 1980-2030	Average Annual Equivalency Factor	Average Annual Equivalency of Increase	Equivalent Average Annual Damages
	1980	1990	2000	2010	2020	2030				
Urban										
Beltrami	13,000	14,300	15,600	16,900	18,200	19,500	6,500	0.2903	1,900	14,900
Agricultural										
Crop	206,000	239,000	271,900	292,500	313,200	346,100	140,100	0.2903	40,700	246,700
Other Agricultural	68,700	74,200	79,700	83,100	86,600	92,100	23,400	0.2903	6,800	75,500
Transportation	11,700	11,700	11,700	11,700	11,700	11,700	--	--	--	11,700
TOTAL	299,400	339,200	378,900	421,100	429,700	469,400	170,000	0.2903	49,400	348,800

Source: Gulf South Research Institute.

Agricultural flood damages consist of crop and pasture damage, which may include costs of replanting, refertilizing, additional spraying, reduced crop yields, loss of animal pasture days, and other related flood losses.

Other agricultural damages consist of land damage from scour and gully erosion and deposition of flood debris; livestock and poultry losses; damages to machinery and equipment, fences, and farm buildings and contents (excluding residences); and damages to irrigation and drainage facilities.

Transportation damages include all damages to railroads, highways, roads, airports, bridges, culverts, and waterways not included in urban damages. In addition, all added operational costs for railroads and airlines and vehicle detours are included.

Future growth of urban flood damages was estimated to be an uncompounded (straight-line) rate of one percent per year for a 50-year period beginning in the base year, with no growth thereafter.

Agricultural crop flood damages were projected to increase at the same rate as crop income projections published in the 1972 OBERS Series E projection report. These crop income projections were prepared by the U.S. Economic Research Service (ERS) for the Red River of the North region. Other agricultural flood damages were projected to increase at one-half of this rate.

Transportation damages are not expected to change throughout the project life because of the long-term economic life associated with such structures as bridges, railways, roads, and culverts. In addition, it has been found that repairs to these types of structures rarely exceed the cost of a new structure, even with frequent flooding.

Most Probable Environmental Conditions

The general poor water quality of the Sand Hill River should improve with point and nonpoint abatement projects. Since abatement of the nonpoint sources will require a longer period of time, they will continue to add to the degradation of the water quality with increased turbidity and unfavorable nutrients. If a flow is maintained on the river, this will help to stabilize the water quality.

Windbreaks, shelter belts, and other similar projects will continue to increase the woodland wildlife habitats, barring changes in land use trends from 1969 to 1977. On the other hand, wetland areas will continue to decrease, both in number and areal extent, due primarily to conversions for agricultural purposes. The reductions of these highly productive areas will consequently result in a decrease in floral and faunal populations. The aquatic habitats will be benefited after the polluting point sources have been abated. The nonpoint sources will continue to create an unfavorable habitat for the more desirable sport fishes.

Without Project Conditions

It is anticipated that the conditions that will prevail over the 50-year planning period in the absence of a plan to alter resource management procedures will be the same as those set forth previously under the most probable future scenario.

VI. EXISTING FLOODPLAIN MANAGEMENT PROGRAMS

VI. EXISTING FLOODPLAIN MANAGEMENT PROGRAMS

Institutions

The development of effective water resources management practices in the subbasin is affected by the large number of Federal, state, and local agencies involved in project planning and implementation. There are 44 Federal agencies with various types of jurisdiction, and 14 directly involved in the water and related land resource planning process. At the state level, 27 agencies are involved. There are also regional commissions, county agencies, and municipal entities. Differences in perspective and problems of coordination hamper the effective and speedy resolution of problems.

The subbasin is aided in water resources development by the inclusion of the area in the Sand Hill Watershed District, which was organized in 1975 and completed an overall plan the following year. There are also four soil and water conservation districts (SWCD) that have jurisdiction in the subbasin, including: the Mahnomen County SWCD, Agassiz SWCD, (Norman County), and the East and West Polk districts. The Corps of Engineers completed one project within the subbasin in 1956, but the Soil Conservation Service has not constructed any floodwater control or drainage measures.

The Corps of Engineers, the Soil Conservation Service, the four soil and and water conservation districts, and the towns of Beltrami and Climax are the main entities that should be consulted in flood control planning for the subbasin. The town of Winger should be included in the planning of structural measures in upland areas to control downstream flooding. It should be noted that the Northwest Central Regional Development District has developed an overall economic development plan that includes the subbasin area.

Structural Measures

Numerous state, county and judicial ditches and stream channels have been constructed throughout the subbasin. Generally, the improved channels function satisfactorily for frequent floods of short duration

but are inadequate for less frequent floods of longer duration. This situation is particularly true for the channels that are not maintained.

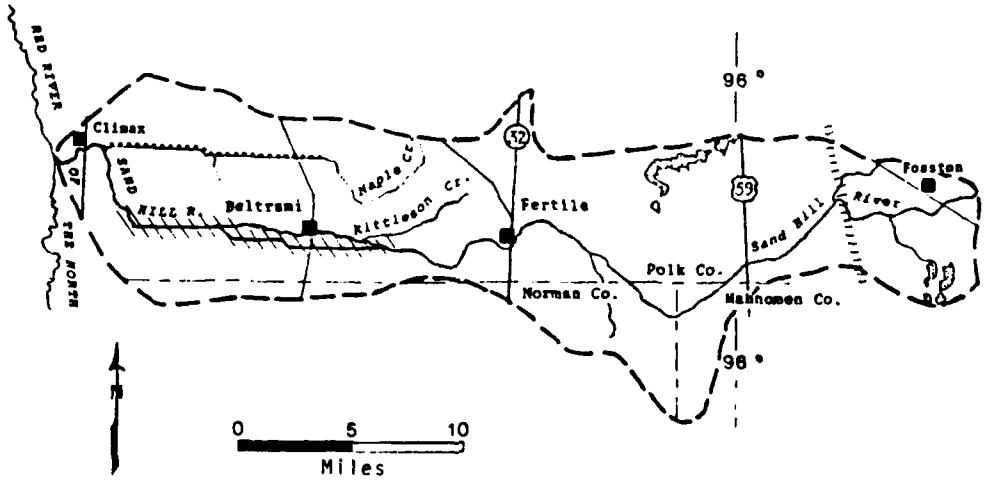
No floodwater control and agricultural management (drainage) measures have been constructed by the Soil Conservation Service (SCS). One such project has been constructed by the Corps of Engineers. This structural measure included about 20 miles of channel straightening, clearing, and enlargement along the Sand Hill River and Sand Hill Ditch. The location of this project, which was completed in 1958, is shown on Figure V. The project included a southward diversion of Kittleson Creek to the Sand Hill River at a point six miles east of Beltrami and straightening and enlargement of the Sand Hill River and Sand Hill Ditch channel starting about 13 miles above the mouth to a point about six miles east of Beltrami. The Corps of Engineers presently is performing a reconnaissance study (under Section 216 of the Flood Control Act of 1970) to review the existing project to determine its effectiveness and to investigate alternative measures to alleviate flooding.

Nonstructural Measures

Nonstructural flood control measures are measures that reduce or eliminate flood damages through procedures that involve little, if any, construction efforts. The major types are flood warning, floodplain zoning, flood insurance, flood proofing, and floodplain evacuation. These measures are primarily applicable to urban areas. Although urban flood damages in the subbasin are not substantial, some nonstructural measures have been instituted, including:

1. Flood insurance in Polk and Mahnomen counties.
2. Flood insurance and floodplain zoning ordinances in Norman County.
3. Flood insurance in Beltrami, where most of the urban damages take place.

All of the towns in the subbasin participate in the Red River Valley flood warning system. The flood warning system for the Red River Valley is a cooperative network organized by the National Weather Service in Fargo, North Dakota. Fifty volunteers throughout the basin report to the National Weather Service on a weekly basis during winter and fall and on a daily basis during spring and summer. The reportage covers



— — Subbasin Boundary

EXISTING AND AUTHORIZED PROJECTS

\\\\ Corps channel improvements complered

..... Ditches

Source: Gulf South Research Institute.

Figure V. EXISTING FLOOD CONTROL MEASURES

all precipitation of 0.1 inch or more, including amount of snow and water equivalent. This information is transmitted to the River Forecast Center in Minneapolis, where it is run through a computer system to determine probable flood stages. The predictions are then transmitted to the National Weather Service in Fargo, which releases them to the public through the news media. Communities are then able to engage in emergency actions to protect themselves from flood damages. Contacts with local officials indicate that the flood warning system generally works quite well in the subbasin.

There are other types of measures that could be used in the subbasin to reduce flood damages but that are not directly applicable to urban areas. These measures would include such things as land treatment programs, use of present drainage ditches for floodwater storage, use of natural areas for water retention, and acquisition of previously drained natural areas for reversion to water retention use. Land treatment is used by some farmers in the subbasin, but the SCS has not been called upon to undertake a large-scale program. Present drainage ditches are not used for floodwater storage, and no plans have been developed for future use. Information on natural storage areas and potentialities for increased storage is limited. Indications are, however, that wetlands play a substantial role in controlling runoff, especially in combination with good land treatment practices. Values on storage have averaged about 12 inches per surface-acre of wetlands, and have ranged to four times that amount (Cernohous, 1979). The amount of wetland habitat within the watershed area (or subbasin) is important: statistical studies indicate that in certain situations if a watershed has 15 percent of its area in wetlands or lakes, peak floods will be 60 to 65 percent lower than they would be in the absence of the wetland/lake area; if wetlands or lakes occupy 30 percent of the watershed, there will be a further reduction in flood peaks up to about 75 to 80 percent (Scientists' Report, National Symposium on Wetlands, 1978).

Adequacy of Existing Measures

Although maintenance efforts by local interests have been minimal, the Corps project constructed in the subbasin is generally in good to excellent condition. There are two problems that aggravate flood conditions.

The first is bank sloughing; the second is that during construction, all spoil material was deposited on the left (south) side of the channel immediately upstream of Beltrami. Although the improved channel has sufficient capacity for summer rainstorms, spring snowmelt often exceeds channel capacity. The material deposited on the left side of the channel forces overbank flow to the right and potentially could cause additional damage to the town.

VII. CRITERIA AND PLANNING OBJECTIVES

VII. CRITERIA AND PLANNING OBJECTIVES

Floodplain Management Criteria

Technical, economic, and environmental criteria must be considered when formulating and evaluating alternative floodplain management measures for the subbasin.

The technical criteria used in formulating and evaluating alternatives for this report consisted of the application of appropriate engineering standards, regulations, and guidelines.

Economic criteria entailed the identification and comparison of benefits and costs of each measure. Tangible economic benefits must exceed costs; however, in certain instances, considerations of appropriate gains in the other accounts (environmental quality, social well-being and regional development) could alter this requirement. All alternatives considered are scaled to a design which optimizes benefits. Annual costs and benefits are based on an interest rate of 7 1/8 percent and price levels and conditions existing in October 1979. A 50-year amortization schedule is used for the features considered.

Environmental considerations call for the formulation of measures that minimize objectionable or adverse environmental effects and maximize environmental benefits. Also, limited consideration was given to modifications based on coordination with state and Federal agencies, local interests, and citizens groups.

Planning Objectives

The primary planning objective of this study was to contribute to flood reduction needs in the subbasin and thereby provide protection from or reduction of flood losses. In conjunction with this economic objective, the study attempted to develop contributions to the environmental quality of the subbasin.

The development of planning objectives involved a broad-range analysis of the needs, opportunities, concerns, and constraints of the subbasin from the information available. On the basis of the identified problems, needs, and desires, the following planning objectives were established:

1. Contribute to protection from and prevention, reduction, or compensation of flood losses for the flood prone areas of the subbasin during the period of analysis.
2. Contribute, to the maximum extent possible, to the preservation of the quality of the existing riverine environment and enhance the environmental potential of the subbasin as a whole.
3. Contribute to the enhancement of recreational opportunities throughout the subbasin.
4. Contribute to the improvement of water quality in the Sand Hill River.
5. Contribute to the improvement of water supply in the western portion of the subbasin.
6. Contribute to the reduction of wind and water erosion throughout the subbasin.
7. Contribute to the developing trend toward increased irrigation throughout the subbasin by investigating surficial sand aquifers.
8. Contribute to the reduction of wastewater management problems, particularly insofar as they relate to water quality.

VIII. FORMULATION OF ALTERNATIVE MEASURES

VIII. FORMULATION OF ALTERNATIVE MEASURES

This section contains a discussion of the management measures that have been identified to meet the resource management objectives. In the formulation of measures, prime consideration was given to the resolution of flooding problems. Measures to meet the other planning objectives were considered exclusively as components of the flood control measures.

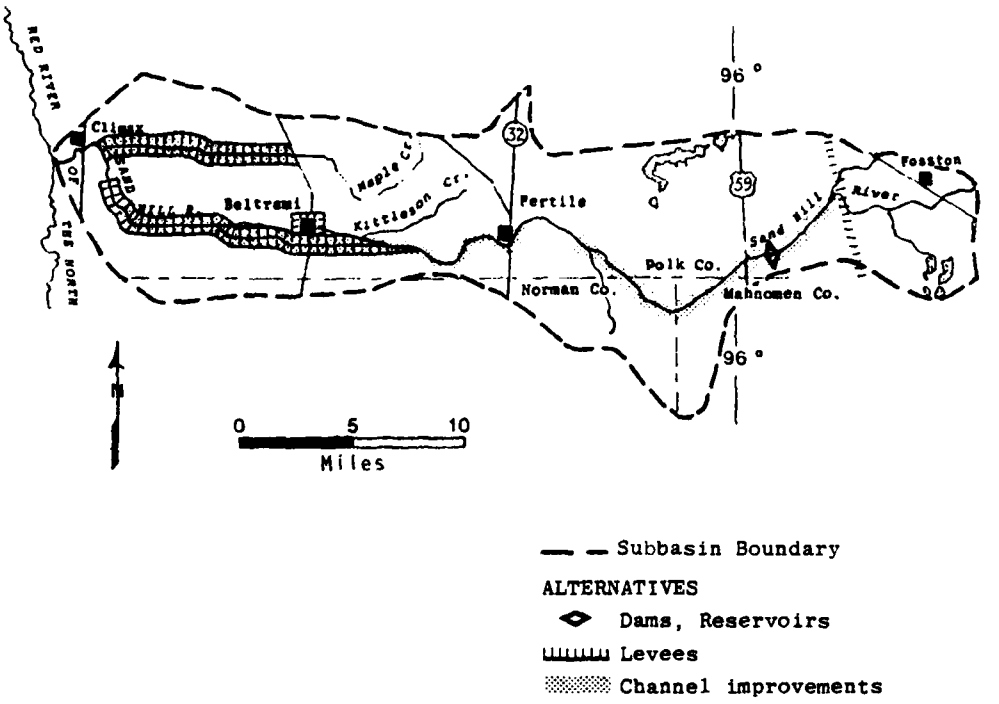
Structural Measures

The following structural measures, which are shown on Figure VI, were devised in response to the flood planning objective:

1. Agricultural levees constructed along each side of the Sand Hill River and Maple Creek from near the mouth to high ground upstream. This measure includes about 71 miles of levees along both sides of the aforementioned streams. The Sand Hill River levees begin near County Ditch 90, about one mile southeast of Climax, and extend upstream to the escarpment about seven miles east of Beltrami. The Maple Creek levees extend 12.5 miles upstream to the Great Northern Railroad. A total of 25 miles of levees are along Maple Creek, and the remaining 46 miles are along the Sand Hill River. The existing Sand Hill River Channel from the mouth to County Ditch 90 is over 25 feet deep and has adequate capacity for the one percent (100-year flood).

   The levees would meet the recently devised Minnesota-North Dakota agricultural levee criterion stipulating that the flood stages of the one percent chance flood should not be increased more than 0.5 feet. They would cause a water level rise of no more than 0.5 feet, with a miximum floodplain width of 3,500 feet, decreasing to a minimum of about 400 feet at the upstream termination and would protect 16,539 acres in the subbasin's one percent chance floodplain. The levees would provide for protection against a one percent frequency flood for the whole of the subbasin, including the town of Beltrami. The implementing agency would be the Corps of Engineers.

2. Improvement of 59 miles of channels on Maple Creek and the Sand Hill River to contain a 10 percent (10-year) frequency flood. This analysis also considered the 30 percent (3.3-year) frequency flood; however, present channels of these streams generally are adequate for this flood. Stream data for this subbasin compiled since 1958 indicates that discharges for the 10 percent flood now are greater than those used to design the 1958 improvements. Therefore, the improved channel would have to be modified somewhat to contain the 10 percent flood. This measure includes 12.5 miles of Maple Creek channel improvements and 46.5 miles of Sand Hill River channel improvements. Maple Creek improvements would extend upstream to the Great Northern Railroad, and Sand



Source: Gulf South Research Institute.

Figure VI. ALTERNATIVE FLOOD CONTROL MEASURES

Hill River channel improvements would extend upstream to near McIntosh, Minnesota. This measure would protect 15,790 acres and Beltrami from the 10 percent flood. The implementing agency would be the Corps of Engineers.

3. Construction of a reservoir having 25,000 acre-feet of flood storage on the Sand Hill River near Winger. This measure also provides protection for the 10 percent flood for 15,790 acres and Beltrami. The implementing agency would be the Corps of Engineers.

4. Construction of 59 miles of channel improvements and the upstream reservoir having 25,000 acre-feet of flood storage. This measure is a combination of the two preceeding measures. Combining the 10 percent channel with the reservoir provides five percent (20-year) flood protection for 23,200 acres and Beltrami. The Corps of Engineers would be the implementing agency.

5. Flood protection for Beltrami. This measure provides for a levee system around Beltrami to provide one percent flood protection. Portable pumps would be used to pump runoff and/or stormwater over the levees during floods. The measure provides no flood protection for rural areas. The implementing agency would be the Corps of Engineers.

6. Construction of levees around individual farmsteads in the one percent floodplain. These levees would protect individual farmsteads against the one percent flood and could be constructed by the SCS, the Corps of Engineers, or private interests.

Engineering Methodology

All structural alternatives were analyzed on the basis of the effects of one (100-year), five (20-year), 10 (10-year) and 30 (3.3-year) percent floods in the subbasin occurring independently of flooding caused by Red River of the North backwater and/or overland flooding from other streams. In order to develop the various alternatives, flood probability versus discharge curves were used to construct drainage area versus discharge curves for the one, five, 10, and 30 percent floods. Cross-sections from prior reports and USGS quadrangle maps and stream hydrological data were used to delineate the various floodplains. Area flooded versus chance of exceedence in one year curves for the various levee and channel improvement schemes and the present condition were developed from the aforementioned data and used to estimate average annual benefits and damages. Capital costs for the various alternatives were developed by updating capital costs from prior studies to October, 1979 price levels; by using October, 1979

unit construction costs; and by a cost versus volume curve for reservoirs developed from cost data obtained from prior studies and projects in the St. Paul District, other Corps of Engineer District projects and studies, the Bureau of Reclamation, and the Tennessee Valley Authority. Woodlands have been taken into account in estimating average annual benefits and damages. It is emphasized that there is very little available hydrological data for the subbasin. The analysis of flood damage reduction alternatives and resulting estimates of benefits, damages, and capital costs has been based on this limited data, hydrological data from similar basins, and, in many cases, the contractor's experience and judgement. Capital cost estimates for levee schemes include the cost of pumping facilities. The analysis of pumping costs was based on using portable pumps sized to pump the 20 percent (five-year) frequency flood.

Nonstructural Measures

Floodplain zoning ordinances and building codes would be a viable alternative in limiting the growth of urban damages at Beltrami and at other towns in the subbasin that sustain flood damages. However, in this, as in most subbasins, the primary damages are agricultural in nature and would not be affected by urban nonstructural measures. There is an opportunity for the use of land treatment measures throughout the subbasin that would help to contain water on land as well as reducing erosion damages. Potentials for water retention in existing ditches should be considered. Natural retention areas should be considered for preservation. However, these would need to be identified, and their retention capacities would need to be determined. In addition, there may also be opportunities for wetland restoration.

IX. ASSESSMENT OF ALTERNATIVES

IX. ASSESSMENT OF ALTERNATIVES

Economic Assessment

The terrain in the lower reaches of the subbasin is very flat, and flood flows in excess of channel capacities inundate almost all of the low flat land. In recent decades, small lakes, swamps, and potholes have been drained for agricultural purposes in all portions of the subbasin. The Sand Hill River Watershed District's Overall Plan reported that the majority of these actions probably have increased the rate of runoff and resulted in additional flooding problems on the lower reaches. However, there is some speculation that cultivation of certain shallow basins may actually have decreased runoff rates by disturbing the impermeable soils of the low wetlands and allowing excess surface water to percolate down into the subsoils.

Average annual benefits were derived by either updating average annual benefits from prior reports to October 1979 levels, or else by applying updated weighted damage per acre figures from the draft Section 205 Detailed Project Report for Flood Control, Snake River Below Warren, Minnesota, which was completed by the St. Paul District Corps of Engineers in 1979.

Economic evaluation of the six proposed flood control alternatives (Table 16) indicated that only Alternative 6 had a benefit/cost ratio high enough to justify implementation. This particular alternative would involve the construction of farmstead levees around individual farmsteads located in the flood-prone areas. These levees would provide protection against a one percent (100-year) frequency flood. Economic analysis of this alternative yielded a benefit/cost ratio of 2.10.

Impact Assessment

Table 17 provides a general assessment of anticipated effects on the key resource elements of the study area resulting from each of the seven alternative measures being considered. The rationale developed for the ratings assigned each measure is presented below.

Table 16

ECONOMIC EVALUATION OF ALTERNATIVES, SAND HILL RIVER SUBBASIN

Alternatives	Acres Protected	Average Annual Acres	Capital Costs	Average Annual Costs	Average Annual Rural Benefits	Average Annual Urban Benefits	Total Average Annual Benefits	B/C Ratio
1. Agricultural Levees (1 percent flood)	16,539	1,083	$ 5,958,000	$ 438,600	$64,700	$14,900	$79,600	0.18
2. Channel Improvements (10 percent flood)	15,790	409	4,115,000	302,900	24,400	2,500	26,900	0.09
3. Upstream Reservoir (25,000 acre feet; 10 percent flood)	15,790	1,173	11,500,000	846,500	70,100	7,500	77,600	0.09
4. Upstream Reservoir and Channel Improvements (20 percent flood)	23,200	1,158	16,037,000	1,180,500	69,200	7,300	76,500	0.06
5. Urban Levees at Beltrami (1 percent flood)	--	--	735,000	54,100	--	14,900	14,900	0.28
6. Farmstead Levees (per levee)	--	--	5,600	400	840	--	840	2.10

Source: Gulf South Research Institute.

Table 17

ASSESSMENT OF MEASURES, BY RESOURCE ELEMENT,
SAND HILL RIVER SUBBASIN

Measures	Social	Economics	Land Use	Biology	Water Quality	Water Supply	Cultural	Recreation
Agricultural Levees	MoB	MoB	NKE	MoB	MiA	NKE	NKE	MiB
Channel Improvements (10 percent flood)	MoB	MoB	NKE	MiA	MiA	NKE	NKE	NKE
Upstream Reservoir (25,000 acre-feet)	MoB	MoB	NKE	MoA	MiA	NKE	NKE	MiB
Upstream Reservoir and Channel Improvements (20 percent flood)	MaB	MaB	NKE	MaA	MoA	NKE	NKE	MiB
Flood Protection-Beltrami	MoB	MoB	NKE	MiA	NKE	NKE	NKE	NKE
Farmstead Levees	MiB	MiB	NKE	NKE	NKE	NKE	NKE	NKE

Note: NKE = No Known Effect
MiA = Minimally Adverse
MoA = Moderately Adverse
MaA = Maximially Adverse
MiB = Minimally Beneficial
MoB = Moderately Beneficial
MaB = Maximally Beneficial

Source: Gulf South Research Institute.

Agricultural Levees

The most desirable structural flood control measures for the subbasin from an economic, social, and environmental viewpoint are the agricultural levees. The levees would afford urban protection to Beltrami and flood protection to over 16,500 acres in the subbasin. Vegetation communities would be protected and habitats would be expanded or created in association with the levee setbacks. Temporary turbidity would minimally adversely affect water quality. Small recreation benefits would result from the utilization of borrow pits for fishing purposes. The effect on water supply, land use, and cultural elements in unknown.

Channel Improvements

Channel improvements would yield moderately beneficial social and economic effects, some adverse biological effects, and short-term adverse results for water quality elements. The effects with respect to land use, recreation, water supply, and cultural elements are unknown.

Social and economic benefits would accrue from the flood protection and flooding reductions that would stem from the project. Some 16,000 acres in the subbasin and the town of Beltrami would be afforded such protection. Biological and water quality elements would be affected negatively by dredging activities, vegetation removal, and temporary turbidity.

Upstream Reservoir

A small upstream impoundment with a total storage capacity of 25,000 acre-feet would also have moderately beneficial social and economic effects. The benefits would accrue mostly from protecting some 8,000 acres from flooding. Recreation would be beneficially, although minimally, affected. Minimally adverse effects would be experienced by water quality elements since construction would result in temporary degradation. Moderately adverse results would be experienced by biological elements, largely due to the disruptions and changes in the existing habitat. The effects with respect to land use, water supply, and cultural elements are unknown.

Upstream Reservoir and Channel Improvements

The combination of the construction of the 59 miles of channel improvements and the upstream reservoir having 25,000 acre-feet of storage would have maximum economic and social benefits. Over 23,000 largely agricultural acres and the town of Beltrami would be served by these measures. Maximally adverse biological effects would result from habitat disruption and destruction, dredging activities, and temporary turbidity. Water quality might, however, be enhanced in the long run by improved stream flows. Minimally beneficial recreational features can be anticipated. The effects with respect to land use, water supply, and cultural elements are unknown.

Flood Protection-Beltrami

Prevention of flood damages at Beltrami would result in moderately beneficial social and economic effects to the community and subbasin. These beneficial effects include the reduction or prevention of damages to and/or loss of personal property, the potential for disruptions in the delivery of emergency services, drains on community services, temporary or permanent loss of community facilities, loss of community tax base and losses in personal income. In addition, such measures would serve to reduce many of the negative behavioral consequences associated with flooding problems.

Minimally adverse environmental and biological impacts would accrue as a result of project construction. Some streamside floodplain vegetation would be destroyed by project construction, and there would be minor degradation in aesthetic qualities and temporary air and noise pollution.

Farmstead Levees

Minimally beneficial economic and social effects would result from the protection of seven farmsteads in the 100-year floodplain. Minimally adverse effects on land use would be experienced. The other resource elements would not be affected.

X. EVALUATION

X. EVALUATION

Only the farmstead levee measures have benefits that exceed unity; thus, they are the only measures recommended for further analysis as the study process continues. These measures are also the only ones that maximize economic benefits for the subbasin, but they afford only extremely localized protection. Small average urban benefits at Beltrami are associated with the other alternatives. However, the average annual costs are much larger than the average annual benefits. The urban levees measure considered for Beltrami had a benefit-to-cost ratio of 0.28, the highest following the farmstead levees.

The greatest environmental enhancement from structural measures would result from the agricultural levees along the Sand Hill River and Maple Creek, where the large setbacks would provide protection to the riparian belt and would create or expand habitats.

National Economic Development (NED) and Environmental Quality (EQ) plans will be tentatively formulated in association with the Red River of the North basin reconnaissance report.

XI. ADDITIONAL STUDY NEEDS

XI. ADDITIONAL STUDY NEEDS

This report was developed almost entirely on the basis of secondary information from readily available planning documents. Data available from state and Federal agencies was not fully canvassed, and only a limited number of calls were made to the area. In particular, state university libraries and department resources could not be fully utilized. Thus, the document aims only at a broad-brush perspective. In order to provide a more detailed and in-depth analysis of subbasin resources, problems, and potential solutions, the following additional study needs would have to be fulfilled:

1. A literature search should be conducted to obtain available biological data for the subbasin. Fieldwork should be planned to fill in any data gaps which exist with the end result of obtaining good baseline data for the subbasin. This is particularly necessary in those areas where flood control measures have been proposed.
2. Areas of high environmental quality (e.g., prairie remnants) should be identified and inventoried within the subbasin.
3. Knowledge of the location, areal extent, and types of wetlands occurring within the specific subbasin boundaries would be extremely useful in determining whether wetland restoration would assist in alleviating flooding problems, as has been indicated by Cernohous (1979).
4. Primary water and sediment quality data are needed to characterize baseline conditions in the streams of the subbasin, particularly in those areas where channel modifications are proposed.
5. Information pertaining to wastewater management needs to be updated.
6. The information obtained in items 1-5 above would provide an important data base upon which cummulative impacts of flood control projects on environmental resources can be evaluated. These projects include those that are in place or proposed for the subbasin.
7. The potentiality for land treatment measures (e.g., erosion control measures such as cover crops, green belts, reduction in fall tillage, etc.) needs to be thoroughly investigated.
8. The people of the subbasin need to be included in further water resource planning efforts. A public involvement program would provide more complete information on water resource problems and opportunities than is presently available.

9. Studies are needed to determine additional demand for recreational facilities, usage of existing facilities, and potential sites.

10. A review of secondary sources and systematic field reconnaissance is needed to identify archaeological and historical sites.

11. A detailed social profile of the subbasin is needed.

12. A detailed institutional analysis of the subbasin is needed.

13. Subbasin boundaries need to be better defined on the basis of hydrologic conditions, and total acreage in the subbasin needs to be precisely measured.

14. An adequate 100-year floodplain map needs to be developed. Also, the extent of floodplains for smaller frequency storms needs to be delineated.

15. Land use within the floodplain needs to be precisely identified.

16. The irrigation potentials of the subbasin soils need to be investigated.

17. The effect of drainage works on flood discharges and stages is unknown at present. It would take additional, more detailed studies to determine the extent and effect of reduced natural storage.

18. Potentialities for floodwater storage in present drainage ditches need to be investigated.

19. Crop distribution in the floodplain needs to be precisely identified through contact with county agents, and average annual rural damages need to be updated.

20. Urban damages need to be recomputed in a systematic fashion.

21. Whether forested acreages in the floodplain are increasing or declining needs to be precisely determined.

22. More study is needed to determine the precise nature of the water supply problems and potential solutions.

23. More gauging stations need to be developed to provide hydrologic data for establishing flood frequencies and rating curves.

24. Channel cross-sections of the various streams need to be prepared for flood control planning purposes.

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Appendix A
FLOODPLAIN DELINEATION

Appendix A

FLOODPLAIN DELINEATION

Prior to this study, no attempt was made to publish even a generalized delineation of the entire Sand Hill River floodplain. In undertaking this task, the present study utilized all known sources to provide the best available data for generalized delineation at a scale of 1:250,000. Principal sources were: USGS Flood Prone Area Maps (scale 1:24,000), Federal Insurance Administration flood maps (various scales), published secondary sources, U.S. Geological Survey (USGS) 7 1/2 minute topographic maps, and other sources, including derived data where necessary.

The subbasin is fairly representative of Red River subbasins in Minnesota in terms of the availability of floodplain data. The USGS Flood-Prone Area Maps provide detailed and accurate information for the area mapped. Only one map in the Red River main stem portion of the subbasin is available, however.

Federal Insurance Administration Flood Hazard Boundary Maps and Flood Insurance Rate Maps provide important coverage of the Minnesota portion of the Red River Basin. The former are designed only to delineate the 100-year floodplain. The latter are much more detailed and usually more accurate. Over 95 percent of the subbasin (Polk and Norman counties) are covered by Flood Hazard Boundary Maps. There is no coverage of Mahnomen County at present even though it joined the emergency program in 1974.

Other secondary sources, such as the Souris-Red-Rainy River Basins Type II Study (delineating the Red River main stem floodplain) and the Sand Hill River Watershed District Overall Plan were utilized with regard to floodplain descriptions and acreage estimates. Where data was lacking, as in the northwest corner of Mahnomen County, data was inferred from floodplain delineations in Norman and Polk counties. Two USGS 7 1/2 minute topographic maps in this area were also available to the study team.

As noted earlier, data from the above sources was compiled and delineated on USGS 250,000-scale maps. The floodplain indicated was then plainmetered in whole and by segment, with the figures converted to acres and rounded to the nearest 2,000 acres.

Appendix B

INVENTORY OF OUTDOOR RECREATIONAL FACILITIES, SAND HILL RIVER SUBBASIN

Appendix B

INVENTORY OF OUTDOOR RECREATIONAL FACILITIES (WILDLIFE MANAGEMENT AREAS)
SAND HILL RIVER SUBBASIN

Number	Name	Location	Boundary Acres	WMA Managed Acres	Date[1]
1	Burham WMA	Polk Co. 14845W24 Chicog Lake	600.0	400.0	71
2	Chicog WMA	Polk Co. 14845W33 Chicog Lake	2,835.0	1,264.0	71
3	Godfrey WMA	Polk Co. 14844W20 Godfrey Township	630.0	143.0	71
4	Liberty WMA	Polk Co. 14745W09 Beltrami	1,565.0	1,280.0	71
5	Onstad WMA	Polk Co. 14844W36 Kittleson Lake	280.0	81.0	71
6	Rindal WMA	Polk Co. 14743W13 Rindall Lake	80.0	80.0	71
7	Ranom WMA	Norman Co. 14643W05 Bear Park Township	410.0	180.0	72
8	Bejou WMA	Mahnomen Co. 14642W29 Frog Lake	1,693.9	1,373.0	71
9	Dittmer WMA	Mahnomen Co. 14542W06 Frog Lake	561.7	561.0	71
10	Castor WMA	Polk Co. 14741W14 Newton Lake	102.2	78.0	71
11	Kroenig WMA	Polk Co. 14741W26 Newton Lake	33.0	21.0	71
12	Hovland WMA	Polk Co. 14740W27 Fosston	217.0	217.0	71

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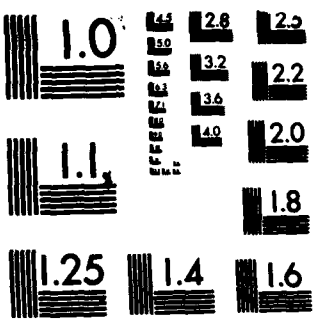


Appendix B (Cont'd)

INVENTORY OF OUTDOOR RECREATIONAL FACILITIES (WILDLIFE MANAGEMENT AREAS)
SAND HILL RIVER SUBBASIN

Number	Name	Location	Boundary Acres	WMA Managed Acres	Date[1]
13	La Voi WMA	Polk Co. 14740W32 Hilligoss Lake	167.8	51.0	71
14	Hasselton WMA	Polk Co. 14740W33 Sand Hill Lake	200.0	200.0	71
	Total Acres:		9,593.6	9,969.0	

[1]Date of latest information.

Source: Minnesota Department of Natural Resources, Division of Parks and Recreation.

Appendix C
COMMENTS

Appendix C
COMMENTS

The purpose of this subbasin report was to provide an overview of the water and related resource problems and needs and to assess potential solutions. Toward this end, draft copies of this report were circulated to Federal, State, and local agencies and comments were sought.

This review resulted in complete and factual documentation. Thus, the study should serve as a building block for the timely completion of future water resource efforts within the subbasin. Further cooperative efforts are, however, needed to evaluate these tentative results and to develop potential solutions.

A distribution list and copies of the comments made with respect to the draft report are included as part of this appendix. Comments that resulted in specific modifications to the draft text are marked by an asterisk.

DEPARTMENT OF THE ARMY
ST PAUL DISTRICT CORPS OF ENGINEERS
1135 U S POST OFFICE & CUSTOM HOUSE
ST PAUL, MINNESOTA 55101

REPLY TO
ATTENTION OF:

NCSED-PB

31 July 1980

Mr. Mike Liffmann
Project Manager
Gulf South Research Institute
8000 GSRI Avenue
Baton Rouge, Louisiana 70808

Dear Mr. Liffmann:

The draft Sand Hill River subbasin report was distributed for review and comment. Most of the reviewers have sent their comments to us.

a. Inclosure 1 includes letters from various Federal and State agencies.

b. Inclosure 2 is the general office comments that need to be considered when preparing the final Sand Hill River subbasin report and the remaining subbasin reports.

c. Inclosure 3 identifies specific office concerns that are applicable to the Sand Hill River subbasin report.

If you have any questions on our comments or proposed modifications, please contact us.

Sincerely,

George A. Skone
for LOUIS E. KOWALSKI
Chief, Planning Branch
Engineering Division

3 Incl
As stated

United States Department of the Interior
FISH AND WILDLIFE SERVICE
St. Paul Field Office
538 Federal Building and U.S. Court House
316 North Robert Street
St. Paul, Minnesota 55101

IN REPLY REFER TO:

July 9, 1980

Colonel William W. Badger
District Engineer, St. Paul District
U.S. Army Corps of Engineers
1135 U.S. Post Office & Custom House
St. Paul, Minnesota 55101

Dear Colonel Badger:

This provides U.S. Fish and Wildlife Service comments on the Draft Reconnaissance Report recently compiled by Gulf South Research Institute for the Sand Hill River Subbasin in Polk, Mahnomen, and Norman Counties, Minnesota.

As expressed in our comments on previous Subbasin Reports, our major concerns are associated with the woodland, grassland, wetland, riverine, and riparian floodplain habitats that remain within the Sand Hill River Subbasin. Much of the native grassland, woodland, and wetland habitat has been converted to agricultural uses. These habitat types that continue to exist are found primarily along the Sand Hill River and other tributary streams within the Subbasin. We agree with the statement on page 11 of the Report that there is a need to protect, conserve, and if possible enhance these remaining wildlife habitat types. We also believe that wetland drainage has been a major factor contributing to the increased rate of runoff and flooding problems that exist along the lower reaches of the Sand Hill River and that this practice needs to be curtailed within the Subbasin.

The Report addressed six structural alternative measures that have been considered to date to reduce the flooding problems within the Subbasin. The Report indicated, however, that only one of these measures (farmstead levees) had a benefit/cost ratio high enough to justify implementation. Our comments relative to these various structural measures (channel improvements, agricultural and urban levees, and reservoirs) are similar to those expressed on previous Subbasin Reports. We believe a plan involving a combination of structural and nonstructural measures (as provided on page 4 of our May 8, 1980 letter on the Draft Reconnaissance Report for the Tamarac River Subbasin) should be implemented. We also believe that additional studies (particularly numbers 2, 3, 7, 17, 18 and 21 identified on pages 66 and 67 of the Report) need to be undertaken to provide a more detailed and in-depth analysis of existing Subbasin problems and the potential solutions to many of these problems.

In addition, we suggest that the following changes be made in the Final Report:

* 1. Page 32, 4th paragraph - add the following sentence following the second sentence in this paragraph:

In addition, there are twelve federal waterfowl production areas within the Subbasin that are open to the public for hunting.

* 2. Page 38, 2nd paragraph (under the heading Waterfowl Production Areas) - change this paragraph to read as follows:

These Waterfowl Production Areas (WPA's) are wetland areas that the U.S. Fish and Wildlife Service (USFWS) has either acquired through fee title or obtained an easement interest on to preserve valuable breeding, nesting, and feeding habitat for migratory waterfowl. These wetland areas are purchased, or an easement interest obtained, with funds received from the sale of Migratory Bird Hunting and Conservation Stamps ("Duck Stamps"). These WPA's are significant because they provide the public with a great variety of wildlife-oriented recreational opportunities as well as providing valuable habitat for migratory waterfowl and many other forms of wildlife. The USFWS is responsible for the compatibility determinations (uses) and the issuance or denial of permits involving these lands. The approximate locations of these WPA's (fee tracts) within the Subbasin are shown in Figure IV. Total acreage of these WPA's (fee and easement) within Polk and Mahnomen Counties, Minnesota are given in Table 12.

* 3. Page 41, Figure IV - put Fee Tracts in parenthesis after Waterfowl Production Areas in the legend. We have attached a copy of Figure IV identifying the approximate locations of ten other WPA's that we believe should also be identified by a dot on this map.

* 4. Page 42, Table 12 - remove the cost column wich is not necessary in this report and simply put Fee (Acres) and Easement (Acres) above the appropriate acreage columns. In addition, change the title to read ACRES OF FEDERAL WATERFOWL PRODUCTION AREAS (FEE AND EASEMENT) WITHIN THE SAND HILL RIVER SUBBASIN.

* 5. Page 53, 1st paragraph, last sentence - we suggest this sentence be changed and the following statements be included in this paragraph:

Information on natural storage areas and potentialities for increased storage is limited. Indications are, however, that wetlands play a substantial role in controlling runoff, especially in combination with good land treatment practices. Valves on storage have averaged about twelve inches per surface-acre of wetlands, and have ranged to four times that amount (Cernohous, 1979). The amount of wetland habitat within the watershed area (or Subbasin) is important: statistical studies indicate that in certain situations if a watershed has 15 percent of its area in wetlands or lakes, peak floods will be 60 to 65 percent lower than they would be in the absence of the wetland/lake area; if wetlands or lakes occupy 30 percent of the watershed, there will be a further reduction in flood peaks up to about 75 or 80 percent (Scientists' Report, National Symposium on Wetlands, 1978).

* 6. Page 70, BIBLIOGRAPHY - include the following reference on this page:

National Wetlands Technical Council, 1978. Scientists' Report, National Symposium On Wetlands. 129 pp.

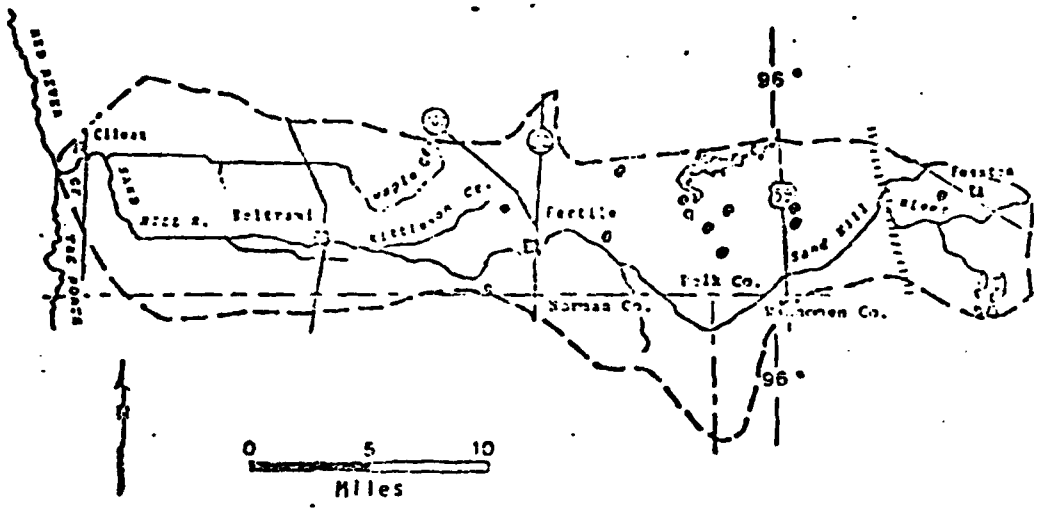
These comments have been prepared under the authority of and in accordance with provisions of the Fish and Wildlife Coordination Act (48 Stat. 401, as amended; 16 U.S.C. 661 et. seq.) and are consistent with the intent of the National Environmental Policy Act of 1969.

Sincerely,

Richard F. Berry

Richard F. Berry
Field Office Supervisor

cc: Minn. DNR, St. Paul
S. Bittner, Gulf South Res. Inst., New Iberia



• SCIENTIFIC AND NATURAL AREA
(Portion of the Agassiz Dunes Tract)

• WATERFOWL PRODUCTION AREAS (FEE TRACTS)

Source: The Nature Conservancy (no date); Miles and Yeager (1979); U. S. Fish and Wildlife Service (1980).

Figure IV. WATERFOWL PRODUCTION AREAS AND SCIENTIFIC AND NATURAL AREAS WITHIN THE SAND HILL RIVER SUBBASIN

United States Department of Agriculture
Soil Conservation Service
316 North Robert St., Room 200
St. Paul, Minnesota
55101

SUBJECT 150-13 BAP, Red River of the North DATE June 20, 1980

TO William W. Badger, Colonel
Corps of Engineers
1135 U.S. Post Office & Custom House
St. Paul, MN 55101

We have reviewed the Snake River and Sand Hill River Subbasins draft reports for the Red River of the North Reconnaissance Study being conducted by GSRI under contract for the St. Paul District U.S. Army Corps of Engineers. The following comments are provided for your consideration:

Snake River Subbasin

1. On page 3, paragraph 2, the elevation at the mouth of the Snake River is described as being about 75 feet. This should be reviewed for accuracy. Also the statement, "The difference in elevation from east to west is 1,075 feet" should also be reviewed for accuracy.

2. On page 3, paragraph 3, the drainage area of the Snake River is described as being 402,560 acres. The drainage area at the mouth of the Snake River should include the Middle River drainage area, however, it appears that this acreage only includes the Snake River subbasin drainage area. This should be clarified for the reader.

3. A portion of the subbasin is located in Pennington County. This item should be clarified on the map on page 4 as well as other maps in the report.

4. It is suggested that the wording in the 2nd sentence, last paragraph on page 7 be changed as follows: "Prior to this study no attempt had been made to publish even a generalized flood plain delineation of the entire subbasin."

5. In the first full paragraph on page 10, the figure of $404,900 should be changed to read $404,000 to agree with the figures shown on page 11.

6. It is suggested that the third paragraph on page 49 starting with the third sentence be revised to read as follows: Applications for PL 566 assistance for the Snake River, Angus-Oslo, and Melgaard-Swift Coulee Watersheds have been approved by the state Soil and

Water Conservation Board. Authorization for planning the Snake River Watershed has been granted by the Chief of the Soil Conservation Service, however, no work has been completed due to funding limitations. Levees constructed around the town of Alvarado..., etc.

7. On page 51, the map shows that SCS has an authorized channel improvement project in the lower part of Snake River. This is not the case, therefore, SCS should not be credited for any channel work in this area.

Sand Hill River Subbasin

* 1. There are numerous typographical errors throughout the report. One such case is on page 8 where the term Kittleson Creek is misspelled. These typographical errors should be corrected.

2. On page 14, there are numerous abbreviations that are not described. These abbreviations should be referenced for the benefit of the reader.

* 3. Page 22, Bemidji is misspelled. This should be corrected so as not to offend any of the readers in that area.

* 4. On page 24, third line, the term futile should probably be changed to fertile.

5. On page 32, the second paragraph, there is a reference to the Ojibway Indian Tribe. In other places in the report conflicting spellings have occurred - Ojibwa and Ojibway. These should be reviewed and changed for consistency.

6. On page 58, the discussion of frequency of flooding is discussed. The term "100-year flood" is used or the "1 percent flood" is used. The recommended terminology for SCS usage is either the "100-year frequency flood" or the "1 percent chance flood." These discrepancies appear throughout the report and should be corrected.

Jon V. DeGroot
Assistance State Conservationist

cc: Ivan R. Wilkinson, RBWP Staff Leader, SCS, St. Paul

USDA:SCS:IRWilkinson:WPC:ldh:6/20/80

DEPARTMENT OF THE ARMY
NORTH CENTRAL DIVISION, CORPS OF ENGINEERS
536 SOUTH CLARK STREET
CHICAGO, ILLINOIS 60605

NCDPD-PF

10 JUL 1980

SUBJECT: Sandhill River Subbasin Reconnaissance Report, Red River of the North Basin

District Engineer, St. Paul

1. Reference NCSED-PB cover letter undated, subject as above.

2. Inclosed are NCD comments on the subject report.

FOR THE DIVISION ENGINEER:

KENNETH H. MURDOCK
Chief, Planning Division

Incl
as

NCDPD-PF 7 July 1980

NCD Comments
on Sand Hill River
Subbasin Reconnaissance Report
Red River of the North

1. Since only the farm stead levee alternative has benefits that exceed unity, we suggest that a public meeting be held to present the alternatives studies. We should stop further study on a project when there is no Federal interest. Suggest that other reports present economic data on costs which may be reviewed. This report is lacking in that department. If costs from other reports are used, they should be presented and the mulitiplier shown which was used to operate the costs.

2. Page 7. Figure II, is a poor map cartographically. Include a legend which clearly describes the patterning used to delineate the 100-year flood plain, marshy areas, etc.

3. Page 16 & 17. Clarify if a public meeting was a part of the public involvement program for this study. If not, explain why a public meeting was not held.

4. Pages 31, 32, and 35. There needs to be a discussion of architectural history in the cultural resources (CR) section. These items should be included in any CR discussion to be in compliance with ER 1105-2-460 and the appropriate legislation.

5. Page 34. Identify which alternative(s) correspond to these modifications which are currently being studied. Also, cross-reference this discussion with the relevant page of discussion and alternative number.

6. Pages 51 & 53. Suggest modifying the explanation of nonstructural measures to include the following:

"Nonstructural measures modify the susceptibility of land, people, and property to damage or losses. In addition they modify the impact of flooding upon people and communities. Nonstructural measures do not attempt to modify the behavior of flood waters."

7. Page 53. Bottom of page the discussion mentions the spoil material being deposited on the south side of the channel and the resultant flooding. Specifically note which alternative addresses this problem, cross-reference to page and number of alternative, and discuss either here or in the alternative formulation section.

8. Page 54. Add a discussion of the National Objectives (NED & EQ) as established by P & S.

Encl 1

9. Page 55. The list of objectives are basically good but awkwardly written. Would suggest rewriting as follows:

"Enhance the recreational opportunities in the Wid-Rice-Marsh Rivers Subbasin for the benefit of the local people."

10. Pages 57 - 59. The list of alternatives needs to be expanded. At a minimum, the nonstructural plan, the least environmentally damaging plan, the NED, and EQ alternatives need to be discussed.

11. Pages 60 - 65. The assessment and evaluation sections need to emphasize how each alternative meets or doesn't meet each objective both study objectives and National Objectives.

STATE OF
MINNESOTA
DEPARTMENT OF NATURAL RESOURCES
444 Lafayette Road, Space Center Bldg., St. Paul, MN 55101
PHONE 612/296-4800 File No

July 7, 1980

Colonel William W. Badger
St. Paul District Engineer
Corps of Engineers
1135 U.S. Post Office & Custom House
St. Paul, MN 55101

Dear Colonel Badger:

COMMENTS ON SAND HILL AND SNAKE RIVER SUBBASIN REPORTS

The Department of Natural Resources, Division of Waters, has reviewed the above referenced documents. Many of the comments that were submitted for previous subbasin reports are pertinent to these documents as well. I hope that the contractor will keep this in mind.

As I stated in my last letter, I realize that it is difficult to analyze proposals when one is forced to use secondary data or no data at all. The main problem is that many of the innovative proposals such as extensive land treatment, floodwater storage in drainage ditches, relocation/aquisition, floodproofing and other non-structural measures are possibly the only alternatives available in some areas, and there is absolutely no data to indicate how feasible these alternatives might be. The only alternatives that are being evaluated are adapted from previous studies or from studies in nearby watersheds. If anything is to come out of this Reconnaisance Study, information is needed on the feasibility of some of these other alternatives. If this is not possible, maybe an assessment could be made on the cost of collecting some of the data that appears to be needed over most of the basin.

With regard to the Snake River Subbasin Report, five economically feasible alternatives are identified on page 62. Either some of these alternatives overlap or else many of the benefits claimed are related to improvements other than flood damage reduction. Average annual damages over the project period are only $474,000 for the whole basin but a total of more than $1,400,000 in average annual benefits are claimed for these measures. More information is needed on how these benefits were derived.

Again, I hope the contractor will utilize these comments and the comments submitted for other subbasins as modifications are made in these documents. If you have further questions please contact Joe Gibson at 296-0438 or Ron Harnack at 296-0440.

Sincerely,

DIVISION OF WATERS

Larry Seymour
Director

LS/JG:ph

cc: Joe Gibson
Ron Harnack

GENERAL COMMENTS
DRAFT SAND HILL RIVER SUBBASIN REPORT
(MAY 1980)

(These comments apply to the entire report and all subsequent subbasin documents.)

1. This document generally needs additional detailed information concerning nonstructural alternatives. Few of the structural alternatives appear feasible; therefore, unless economics are ignored, nonstructural solutions remain important to reduce the magnitude of future flood damages. The overall report should address and clarify this aspect of flood damage reduction planning.

2. Comments from Federal, State, and local agencies and a letter from the St. Paul District will be included in an appendix in each final subbasin and in the overall report. The format for the appendix will be:

a. Introduction - This section should stress:

(1) The importance of completing the study on time.

(2) That the purpose of the study is to advise other agencies and interests.

(3) The need for a selected review by various interests to provide complete and factual documentation.

(4) The use of the study as a building block for future water resource efforts.

(5) That cooperative efforts to evaluate results and develop solutions to remaining problems will be incorporated.

(6) A complete public involvement program when the study is finished.

b. The distribution list.

c. Copies of letters of comment.

Only comments that identify significant errors or need specific attention will be addressed in the final subbasin report. However, all comments incorporated should be identified with a marking system. The distribution list for the final Sand Hill River Subbasin Report is given below:

Agencies receiving draft report	Date sent	Date comments received
Federal		
Soil Conservation Service	12 Jun 80	20 Jun 80
Fish and Wildlife Service	12 Jun 80	9 Jul 80
Corps of Engineers, North Central Div.	9 Jun 80	10 Jul 80
Corps of Engineers, St. Paul District	9 Jun 80	20 Jun 80

Minnesota Water Planning Board	12 Jun 80	-
Department of Natural Resources	12 Jun 80	7 Jul 80
Minnesota State Planning Agency	12 Jun 80	-
Water Resources Board	12 Jun 80	-
Local		
Watershed District	12 Jun 80	-

3. The source for most information identified in the majority of the tables is Gulf South Research Institute. If other sources were used, an appropriate reference should be made.

4. The evaluation section of each report is primarily the recommendations of the document. Generally only the structural alternatives which have a benefit-cost ratio greater than 1 are presented. Little attention is given to the other structural and nonstructural alternatives that may be an important aspect of future flood damage reduction planning for the subbasin and basin as a whole. Therefore, it is recommended that this section be expanded to provide the appropriate discussions.

5. Rather than stating in each report and for each alternative evaluated that there will be little or no effect on cultural resources, the report should indicate that it is not possible to identify effects on cultural resources until a systematic cultural resources survey has been completed in the subbasin. Such statements are misleading since it appears that there are no significant sites in the subbasin. In reality, there are simply no known sites.

6. The supporting information for alternatives, including technical, economic, and any environmental data, should be provided (at least under separate cover). This would simplify matters when questions are asked during review or in the future.

7. The maps should have more detail. Often information in the text is not clearly illustrated in the maps.

8. Almost all of the subbasin documents identify significant water resource problems (i.e., flooding, water supply, water quality, etc.) throughout the subbasin. However, little if any, reduction in flood damages can be expected from the implementation of the economically feasible alternatives. As a result, the overall document is very important if it is to be valuable to the residents of the basin and if it is to serve as a guide for all Federal and State agencies. This document cannot be a reiteration of the subbasin report.

9. In the bibliography all references from the same source during the same year should be listed alphabetically so that those references can be distinguished. References to the U.S. Army Corps of Engineers need clarification throughout the report. These references should be standardized to read "St. Paul District, Corps of Engineers."

SPECIFIC COMMENTS
SAND HILL RIVER SUBBASIN
(MAY 1980)

* 1. Page 1, paragraph 4 - "telephone" is misspelled.

* 2. Page 1, item 1 - Modify to indicate that this was a letter submitted in 1978. Delete "describes...and." Add before project "existing channel improvement."

* 3. Page 3, paragraph 1 - "Mahnomen" is misspelled.

* 4. Page 3, paragraph 2, sentence 2 - Change to reach "Originally forests were here, but..."

5. Page 3, paragraph 2 - The lowest elevation should also be stated.

* 6. Page 3, paragraph 4 - The ditch that is discussed is south of Beltrami and runs east until it reaches the original Sand Hill River Channel. This paragraph and Figure I should be modified to reflect this.

* 7. Page 6, paragraph 2, sentence 1 - Instead of "correlate," a better term might be "coincide." Also, it can be stated that the Red River main stem remains at high stages for considerable lengths of time, and therefore, usually has backwater effect on several tributaries including the Sand Hill.

* 8. Page 6, paragraph 2, last sentence - Change to read "...from the subbasin does not contribute significantly to flooding on the Red River main stem."

9. Page 6, Location and Extent Section - The 100-year floodplain has been delineated at least to some extent, otherwise there would not be flood-prone area maps, etc. Although many of these maps may be inconsistent because of the criteria and regulations under which each one was developed, a general delineation can be accepted. Please provide a copy of your delineation when the report is completed.

* 10. Page 8, paragraph 4 - "Kittleson" is misspelled.

* 11. Page 9, paragraph 1 - The second sentence is awkward.

* 12. Page 12, paragraph 4 - "Turbidity" is misspelled.

* 13. Page 13, Erosion Problems. Delete 4th sentence.

14. Page 14, The abbreviations should be spelled out the first time they are used.

* 15. Page 16, Hydropower Section - Minneapolis-St. Paul is southeast of the Red River basin.

* 16. Page 16, Public Perception of Problems and Solutions Section - Although no official public meetings have been held for residents of the subbasin, this does not mean that the public's perception of the problems and solutions have not been adequately defined. Public meetings are only a small part of the public involvement process. In many cases they are not adequate because of the formality of analyzing such public opinions. There have been informal meetings and discussions with local interests and these same interests have participated in meetings held throughout the basin to discuss flood control problems, needs and solutions.

* 17. Page 16, paragraph 5, last sentence - Change to read "...material on the left bank side of the channel, possibly aggravating flooding in..."

* 18. Page 16, - Delete last sentence as it is not valid.

* 19. Page 19, paragraph 4 - How can Norman County lose 100 people per year and yet have an outmigration rate of 2.2 percent as listed on page 18, paragraph 2? These figures reflect a corresponding population of about 4,545 people. This should be clarified.

* 20. Page 20, Agricultural Section -

a) "Predominant" is misspelled.
b) "Approximately" is misspelled.
c. In addition to factors noted on yields per acre, harvested acres, and total production, it would he helpful if gross income per acre for each crop was included. This information would give a better understanding of the importance of each crop. In addition, the farmer's cost per acre to plant the different crops would contribute to this understanding. Susceptibilities of crops to flood damages should also be presented.

21. Page 21, Manufacturing Section - The other two manufacturers should be identified.

* 22. Page 22, paragraph 2 - "Bemidji" and "Crookston" are misspelled.

* 23. Page 24, paragraph 1 - "futile" should be "fertile."

* 24. Page 26, paragraph 1 -

a) line 5 - change "ducks" to "buds."
b) line 6 - add "species of" between "101" and "breeding."
c) The pheasant numbers of ≤5/100 miles are not adequately explained. Although this population index is useful for the relative comparison of populations in different regions, it is not an indication of population numbers. More importantly, the indices cited, and those available for the other upland game birds mentioned, are relatively low when compared to other regions in Minnesota. The report should reflect this.

* 25. Page 26, last paragraph - The USGS map shows the ditch to start upstream of Kittleson Creek.

* 26. Page 29, paragraph 2, line 2 - Change "possible" to "possibly."

27. Pages 31-32 - The description of cultural elements is short but accurate. The need for further archaeological and historical surveys could be more strongly stated.

* 28. Page 31, paragraph 4, line 3 - "B.P." should be "B.C."

* 29. Pages 36-38 - The source of information for the wetlands data is not adequately referenced in the bibliography. The information cited was in a separate letter report and not a part of U.S. Fish and Wildlife Services 1980 terrestrial resources package. The wetlands report should be cited separately:

U.S. Fish and Wildlife Service 1980b: A letter report concerning wetland data for the Minnesota portion of the Red River of the North. Ecological Services Office, St. Paul, 29 pp.

30. Page 38, Threatened or Endangered Species Section - The perigrine Falcon has apparently been extirpated from Minnesota since the early 1960's. Although the subbasin does lie within the migratory route of the perigrine Falcon, and sitings may occur in the region at this time, the wintering range of this species is south of this subbasin.

31. Page 43, paragraph 2 - The following changes are suggested for the paragraph on colonial birds:

a) The relative abundance figure (1 bird/100 miles) for the great blue heron should be explained. The report should also indicate how this compares with other regions in the State.

b) The paragraph should also specify that the eastern greater Sandhill crane is considered a treatened species in Minnesota and is not listed as threatened by the Fish and Wildlife Service.

* 32. Page 48, last sentence - Change to read "If a flow is maintained on the river, this will help to stabilize the water quality."

* 33. Page 49, first sentence, line 2 - Delete "only."

* 34. Page 51, paragraph 2, last sentence - Change "1979" to "1970."

* 35. Page 53 - Change the last sentence to read "The material... to the right and potentially could cause additional damage to the town."

* 36. Page 54, paragraph 3 - "Comparison" is misspelled.

* 37. Page 54, last paragraph - After "...subbasin." add "from the information available."

* 38. Page 56, Structural Measure 1, paragraph 2, line 2 - Change to read "...stipulating that the flood stages of the 1-percent chance flood should..."

39. Page 58 - What about an alternative to floodproofing and evacuation in Beltrami? These types of alternatives should be investigated and included in the final subbasin report.

* 40. Page 58, Engineering Methodology Section -

a) line 7 - add "5" between "one" and "10."

b) line 9 - modify "change" to "chance."

41. Page 49, paragraph 1, sentence 2 - should explain how "woodlands have been considered in estimating average annual benefits and damages."

42. Page 51, alternative 6 - The capitol costs for farmstead levees seem to be low. The figures should be rechecked.

* 43. Page 60-64 - On page 32 it is stated that archeological surveys will be needed in flood control measure areas to assess the impacts of alternative solutions on cultural resources. If this is true the "no" or "negligible effect" determinations statements in this section as cultural elements including the table should be changed to "unknown effects."

* 44. Page 63, Channel Improvement Section - It is not a valid assumption that channel improvements will result in long term beneficial effects in water quality. Depending on how the channel work is completed, channel improvements could result in; (1) higher peak flows, lower low flows and decreased water velocity because of increased cross-section, (2) increased water temperature due to removal of bank vegetation and (3) increased sediment discharge for several years as the stream channel adjusts to new flow regimes.

Also, on page 8 the report indicates that in the upper reaches of the Sand Hill River, approximately 4,000 of the 10,000 acres in the 100 year floodplain, are marsh areas. Channel improvements in this reach of the river could promote wetland drainage in the area resulting in maximal adverse biological impacts (as opposed to minimally adverse as stated in the report) and contributing to water quality problems.

45. Page 63, Agricultural Levee Section -

a) In most cases, it is not reasonable to assume that existing habitats will be recreated riverward of the levees. Farmers will continue to farm whatever land possible in this area. Also, erosion and sedimentation problems may occur. At best, the total adverse and beneficial impacts may be balanced.

b) The levees, if developed, would probably use borrow from land adjacent to the levee, not from a pit. However, even if a pit were used, it is questionable as to whether the use of borrow pits for fishing purposes is a reasonable recreation benefit. Borrow pits used for this purpose would require some level of fisheries management in order to be successful. The costs associated with these actions are probably prohibitive in this situation, because of the low density population in this area. Therefore, it should not be considered as a recreation benefit.

* 46. Page 63, Channel Improvement Section - Recreation benefits attributable to channel improvements are also questionable. Improved water quality is not always a result of this type of development. Although water quality can be improved by imcorporating fish and wildlife structures, the associate costs are likely to be prohibitive. Only under certain conditions can recreation benefits be anticipated.

47. Pages 66-67, Additional Study Needs Section, #10 - The need for futher literature search and surveys is a good one. This should be accomplished before the assessment of the impacts of the various flood control measures on cultural elements can be made.

The Soil Conservation Service
is an agency of the
Department of Agriculture

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quality is not always
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osts are likely to be
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